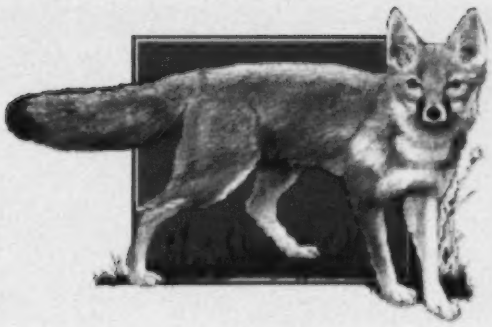
COSEWIC
Assessment and Update Status Report

on the

Swift Fox
Vulpes velox

in Canada



ENDANGERED
2000

COSEWIC
COMMITTEE ON THE STATUS OF
ENDANGERED WILDLIFE
IN CANADA

COSEPAC
COMITÉ SUR LA SITUATION DES
ESPÈCES EN PÉRIL
AU CANADA

COSEWIC status reports are working documents used in assigning the status of wildlife species suspected of being at risk. This report may be cited as follows:

Please note: Persons wishing to cite data in the report should refer to the report (and cite the author(s)); persons wishing to cite the COSEWIC status will refer to the assessment (and cite COSEWIC). A production note will be provided if additional information on the status report history is required.

COSEWIC 2000. COSEWIC assessment and update status report on the swift fox *Vulpes velox* in Canada. Committee on the Status of Endangered Wildlife in Canada. Ottawa. v + 44 pp.

Carbyn, L.N. 1998. Update COSEWIC status report on the swift fox *Vulpes velox* in Canada. Committee on the Status of Endangered Wildlife in Canada. Ottawa. 1-44 pp.

Previous report:

Saskatchewan Department of Tourism and Renewable Resources. 1978. COSEWIC status report on the swift fox *Vulpes velox* in Canada. Committee on the Status of Endangered Wildlife in Canada. Ottawa. 7 pp.

Please note that the status recommended in the Section "Evaluation and Recommended Status" of the report may differ from the latest status assigned to the species by COSEWIC.

For additional copies contact:

COSEWIC Secretariat
c/o Canadian Wildlife Service
Environment Canada
Ottawa, ON
K1A 0H3

Tel.: (819) 997-4991 / (819) 953-3215
Fax: (819) 994-3684
E-mail: COSEWIC/COSEPAC@ec.gc.ca
http://www.cosewic.gc.ca

Également disponible en français sous le titre Rapport du COSEPAC sur la situation du renard véloce (*Vulpes velox*) au Canada – Mise à jour

Cover illustration:
Swift fox — Brian Huffman, Alberta Fish and Wildlife Division

©Minister of Public Works and Government Services Canada 2002
Catalogue No. CW69-14/108-2002E-IN
ISBN 0-662-31876-5

Recycled paper

COSEWIC
Assessment Summary

Assessment Summary – May 2000

Common name
Swift fox

Scientific name
Vulpes velox

Status
Endangered

Reason for designation
The species was previously extirpated from Canada. A small population is now established in Alberta and Saskatchewan through re-introductions. Animals are successfully breeding in the wild, although the species is potentially at risk from coyote predation and habitat loss.

Occurrence
Alberta, Saskatchewan

Status history
Last seen in Saskatchewan in 1928. Designated Extirpated in April 1978. Status re-examined and downlisted to Endangered in April 1998 after successful reintroductions. Status re-examined and confirmed Endangered in May 2000. May 2000 assessment based on new quantitative criteria applied to information from the existing 1998 status report.

COSEWIC
Executive Summary
from the 1998 Status Report

Swift Fox
Vulpes velox

The swift fox began to decline as native grasslands were converted to agricultural lands in the late 1800s. Loss of habitat combined with predation, competition (primarily from coyotes and golden eagles), interspecific competition for food with coyotes, vulnerability to trapping, poisoning programs, drought conditions, and winter severity all likely contributed to the extirpation of the swift fox from Canada by the late 1930s. Captive breeding in Canada began in the early1960's and continued in 1973. This was expanded into an intensive reintroduction project involving federal agencies, universities and non-government organizations. Swift foxes were first released into Alberta and Saskatchewan in 1983 and 1984 respectively. By 1997, 942 foxes had been released in the two provinces.

Reintroduction efforts have been successful. Small populations have become established in the border area of south-eastern Alberta and south-western Saskatchewan and in the Wood Mountain/Grasslands National Park Reserve region in central Saskatchewan. Reproduction is now occurring in these wild populations, and the majority of the current population are wild-born offspring of released animals.

The Canadian swift fox population in 1997 was estimated to be in excess of 289 foxes (95% confidence interval: 179-412 foxes). The Alberta/Saskatchewan border population is estimated to be 192 foxes (95% confidence interval: 93-346 foxes). The swift fox population in the Wood Mountain area is estimated to be 87 foxes. A reliable confidence interval could not be obtained for the Wood Mountain region due to the small sample size.

Eighty per cent of the foxes captured in 1997 were born on the Canadian prairie. Released foxes have survived and reproduced, and their offspring form the core of the fledgling Canadian population. Observations to date suggest that some individual foxes have survived up to 7 years, and possibly longer. Reproduction by a number of pairs in successive years has been documented. In addition to the Canadian population, swift foxes have also been recorded in northern Montana.

COSEWIC MANDATE

The Committee on the Status of Endangered Wildlife in Canada (COSEWIC) determines the national status of wild species, subspecies, varieties, and nationally significant populations that are considered to be at risk in Canada. Designations are made on all native species for the following taxonomic groups: mammals, birds, reptiles, amphibians, fish, lepidopterans, molluscs, vascular plants, lichens, and mosses.

COSEWIC MEMBERSHIP

COSEWIC comprises representatives from each provincial and territorial government wildlife agency, four federal agencies (Canadian Wildlife Service, Parks Canada Agency, Department of Fisheries and Oceans, and the Federal Biosystematic Partnership), three nonjurisdictional members and the co-chairs of the species specialist groups. The committee meets to consider status reports on candidate species.

DEFINITIONS

Species	Any indigenous species, subspecies, variety, or geographically defined population of wild fauna and flora.
Extinct (X)	A species that no longer exists.
Extirpated (XT)	A species no longer existing in the wild in Canada, but occurring elsewhere.
Endangered (E)	A species facing imminent extirpation or extinction.
Threatened (T)	A species likely to become endangered if limiting factors are not reversed.
Special Concern (SC)*	A species of special concern because of characteristics that make it particularly sensitive to human activities or natural events.
Not at Risk (NAR)**	A species that has been evaluated and found to be not at risk.
Data Deficient (DD)***	A species for which there is insufficient scientific information to support status designation.

* Formerly described as "Vulnerable" from 1990 to 1999, or "Rare" prior to 1990.
** Formerly described as "Not In Any Category", or "No Designation Required."
*** Formerly described as "Indeterminate" from 1994 to 1999 or "ISIBD" (insufficient scientific information on which to base a designation) prior to 1994.

The Committee on the Status of Endangered Wildlife in Canada (COSEWIC) was created in 1977 as a result of a recommendation at the Federal-Provincial Wildlife Conference held in 1976. It arose from the need for a single, official, scientifically sound, national listing of wildlife species at risk. In 1978, COSEWIC designated its first species and produced its first list of Canadian species at risk. Species designated at meetings of the full committee are added to the list.

Environment Canada | Environnement Canada
Canadian Wildlife Service | Service canadien de la faune

Canada

The Canadian Wildlife Service, Environment Canada, provides full administrative and financial support to the COSEWIC Secretariat.

Update
COSEWIC Status Report

on the

Swift Fox
Vulpes velox

in Canada

Ludwig N. Carbyn[1]

1998

[1]Canadian Wildlife Service
Western and Northern Region
Edmonton, AB
T6B 2X3

TABLE OF CONTENTS

INTRODUCTION 4
COSEWIC update 4
Status report 4
DISTRIBUTION 4
Fossil report 4
North American distribution 4
Canadian distribution 9
Canadian reintroduction program 11
POPULATION SIZE AND TRENDS 17
Alberta 17
Saskatchewan 17
Manitoba 18
Population structure 18
Legal protection 20
HABITAT 22
General description 22
Habitat destruction 22
Habitat degradation 23
Habitat fragmentation 25
GENERAL BIOLOGY 25
Morphology, description and taxonomy 25
Diet and foraging behaviour 26
Denning activities 27
Mating systems, growth and reproduction 27
LIMITING FACTORS 28
Predation 28
Collision with vehicles 29
Range management 29
Pipelines 29
Fur harvests 29
Impact of droughts 30
Predator control programs 31
SPECIAL SIGNIFICANCE OF THE SPECIES 31
EVALUATION AND PROPOSED STATUS 32
COSEWIC 32
IUCN and other conservation implications 33
Conclusion 35
ACKNOWLEDGEMENTS 35
LITERATURE CITED 35
PROJECT NOTES AND REPORTS 42
THE AUTHOR 43

List of figures

Figure 1. Rough approximation of the possible maximum range of swift foxes on the North American continent during the 19th century and approximate distribution in 1997. 6
Figure 2. A map showing approximately the extent of short/mid grass prairie areas on the North American continent. 7
Figure 3. A map indicating distribution of potential swift fox range in the United States. 8
Figure 4. Map showing approximate distribution of swift foxes in Canada. 10

List of tables

Table 1. Number of pairs of foxes placed in field pens in southern Saskatchewan and Alberta from 1983 to 1987 resulting in the release of 137 foxes (78 adults and 59 young born in the pens) during the soft releases 14
Table 2. Summary of swift fox releases to reintroduce fox populations into southern Canada in a reintroduction project involving the hard release technique 15
Table 3. Number of foxes released in the East Block and West Block of Grasslands National Park, Saskatchewan 15
Table 4. Summary of number of foxes imported from 1973 to 1996 for the Canadian reintroduction program. These foxes were used for both captive breeding and releases 16

INTRODUCTION

COSEWIC update

In 1978 the status of swift foxes in Canada was designated by COSEWIC as "Extirpated" (Saskatchewan Department of Tourism and Renewable Resources 1978). At the time the conclusion was that "many authorities consider the swift fox extinct in Canada. There have been sightings over the past few years but none can be considered as confirmed."

Status report

Status reports provide current information on species that have been identified for special consideration. The swift fox was returned, as a result of a reintroduction program, to parts of its original Canadian range. The ecological consequences of the disappearance of the species have never been evaluated. Similarly, its niche within altered ecosystems following reintroduction has not been fully evaluated. This report documents the restoration and numerical status of a small carnivore once present, then missing, and now returned to one of Canada's most threatened ecosystems.

DISTRIBUTION

Fossil report

Three fossil teeth belonging to a very "small" fox were found among early Blancan (late Pliocene) mammal remains in Texas (Dalquest 1978). *Vulpes velox* finds in Texas were from the Pleistocene period and from late Wisconsinan to Holocene cave deposits in eastern Missouri (Kurten and Anderson 1980 and Parmalee *et al.*, 1969). Those areas are outside of the current range of the swift fox and are indications of long term changes in swift fox distribution.

The Alberta Provincial Museum, Edmonton, Alberta has a number of specimens, some of which appear to be those of swift fox, although verification is still required. These were obtained from Exshaw, Stettler, Highwood area (Calgary); Balzac and Calgary (J. Burns pers. comm.). Published information for Alberta is available from specimens found at January cave, Alberta. There is some question as to the dates, however, material recovered ranged in age between about 23,000 to 33,500 BP (Burns, 1991).

North American distribution

The swift fox is native to the North American short/mixed grassland prairies of the Great Plains region. Suitable swift fox range in Canada is restricted to the southern portions of the prairies, namely Alberta, Saskatchewan and possibly Manitoba. This region coincides with the northern edge of the continental range of the species.

It is difficult to reconstruct the size of the historical range of swift foxes on the continent. One estimate (Scott-Brown *et al.*, 1987) places it at 1.6 million km^2 (624,000 mi^2). This would include the area from central Texas, north to central Alberta and from the Rocky Mountains to about 95° west longitude, or further east to west between western Iowa and the eastern half of Colorado (Fig. 1). Historical range maps include western Minnesota and Iowa (Hall 1981, Scott-Brown *et al.*, 1987, Samuel and Nelson 1992, Fauna West 1991) but specimens were never (as far as is known) obtained from these areas for verification (Swanson *et al.*, 1945; Allen 1870; Bowles 1975 and Kahn *et al.*, 1997). A rough estimate, based on vegetation mapping, (Kahn 1997 *et al.*) is that the species currently can be found in about 40% of its former U.S. range.

The ability by management agencies to accurately assess numbers is still open to wide interpretation. In a status evaluation of swift foxes in the United States, the United States Fish and Wildlife Service initially upheld a 1992 drafted petition to list the species as a candidate endangered species. After the 90 day finding, the USFWS initiated a 12-month finding to further review the status. That review resulted in the conclusion that the swift fox was deemed extirpated in most of its original historic range and found only in isolated pockets in remaining grassland areas. The official designation of the swift fox was that it was indeed a valid endangered species candidate and, listing was "warranted but precluded" by the need to address other, higher priority species at risk.

The distribution was probably always patchy and disjunct in some areas and continuous in others (Hoffman *et al.*, 1969; Pfeiffer and Hibbard 1970; Moore and Martin 1980; Fitzgerald *et al.*, 1983; Giddings and Knowles 1995; Kruse *et al.*, 1996; Allen, 1996). In general, the U.S. range included Colorado, Wyoming and Montana, Kansas, Nebraska, North and South Dakota and western Oklahoma and Texas. After major declines up to the turn of the century, and in some areas (e.g. South Dakota) as recently as the 1960's and 1970's, the species has made a slight comeback.

Current knowledge of continent-wide abundance and distribution is incomplete. The potential short grass/mixed grass prairie ecoregion currently mapped in North America (Figures 2 and 3) is possibly 20% less than the most "optimistic" historic swift fox range as one could expect from the literature. The original distribution of the species was primarily influenced by the extent of native prairies. This is still the case for most areas but exceptions do occur.

Human activities in the late 1800's and first quarter of the 1900's changed the prairie landscape (Coupland 1950 - see also section on habitat degradation). Loss of prairie habitat, predator control, unregulated trapping/hunting, rodent control, road construction, widespread use of pesticides/herbicides, loss of other grassland faunal components (e.g. bison, wolves) and long term climatic changes have all been implicated in the reduction of swift fox numbers in the United States and complete extirpation in Canada. The above list represents suppositions, about which there are no empirical data to define precise reasons for reduction in swift fox populations on the continent.

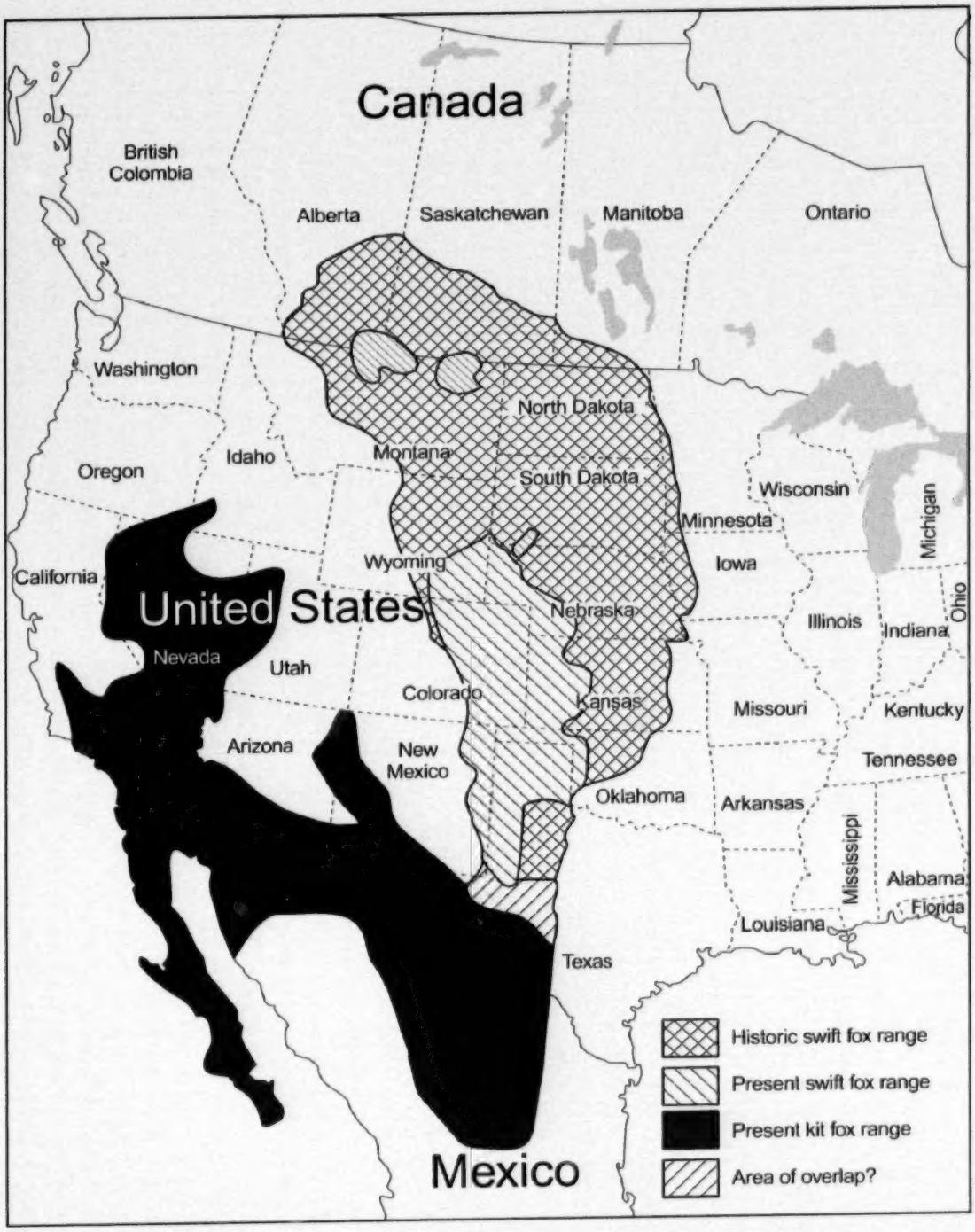


Figure 1. Rough approximation of the possible maximum range of swift foxes on the North American continent during the 19th century and approximate distribution in 1997.

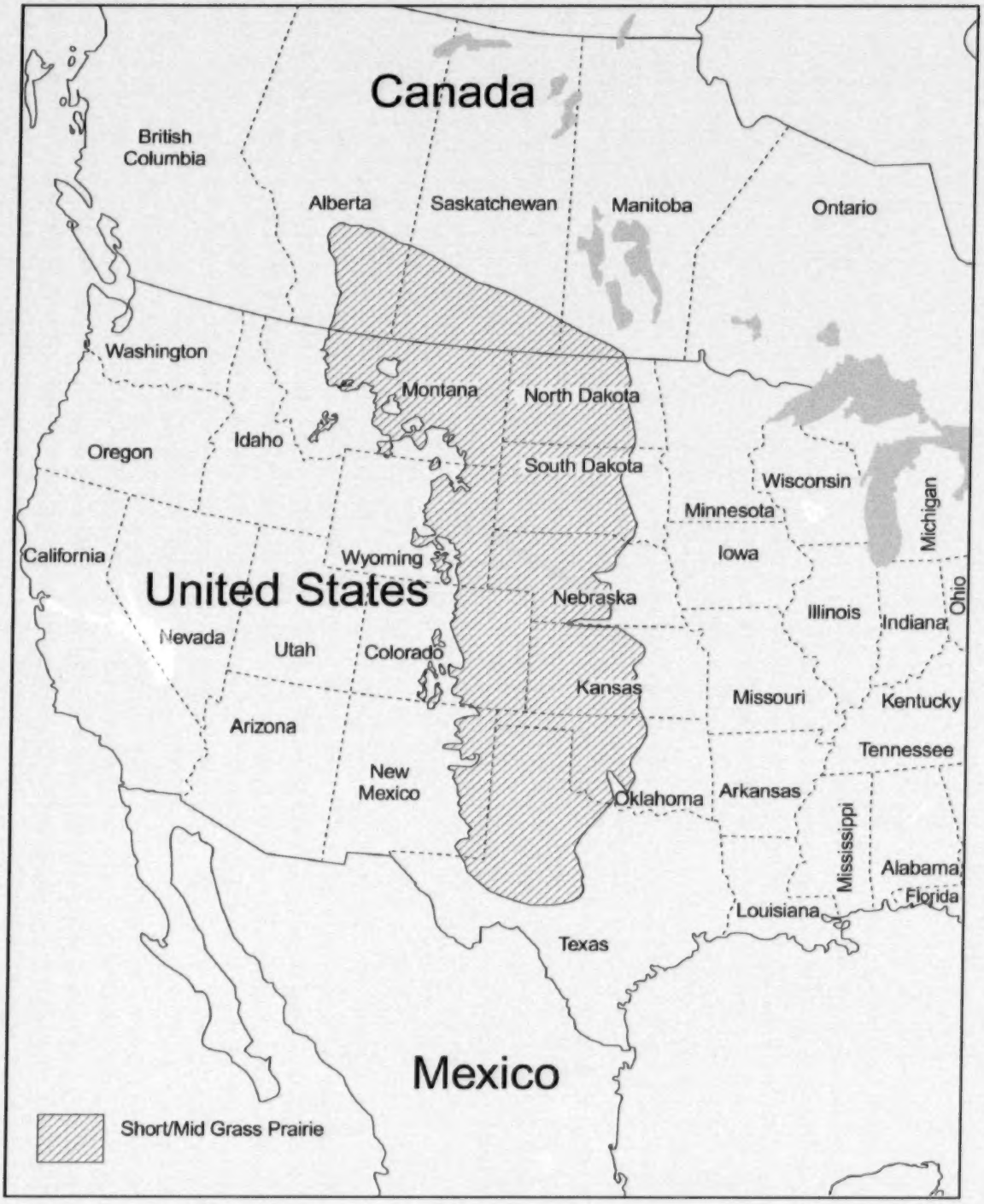


Figure 2. A map showing approximately the extent of short/mid grass prairie areas on the North American continent, based on a modified interpretation by Lauenroth (1966) and the Canadian Prairie Conservation Action Plan.

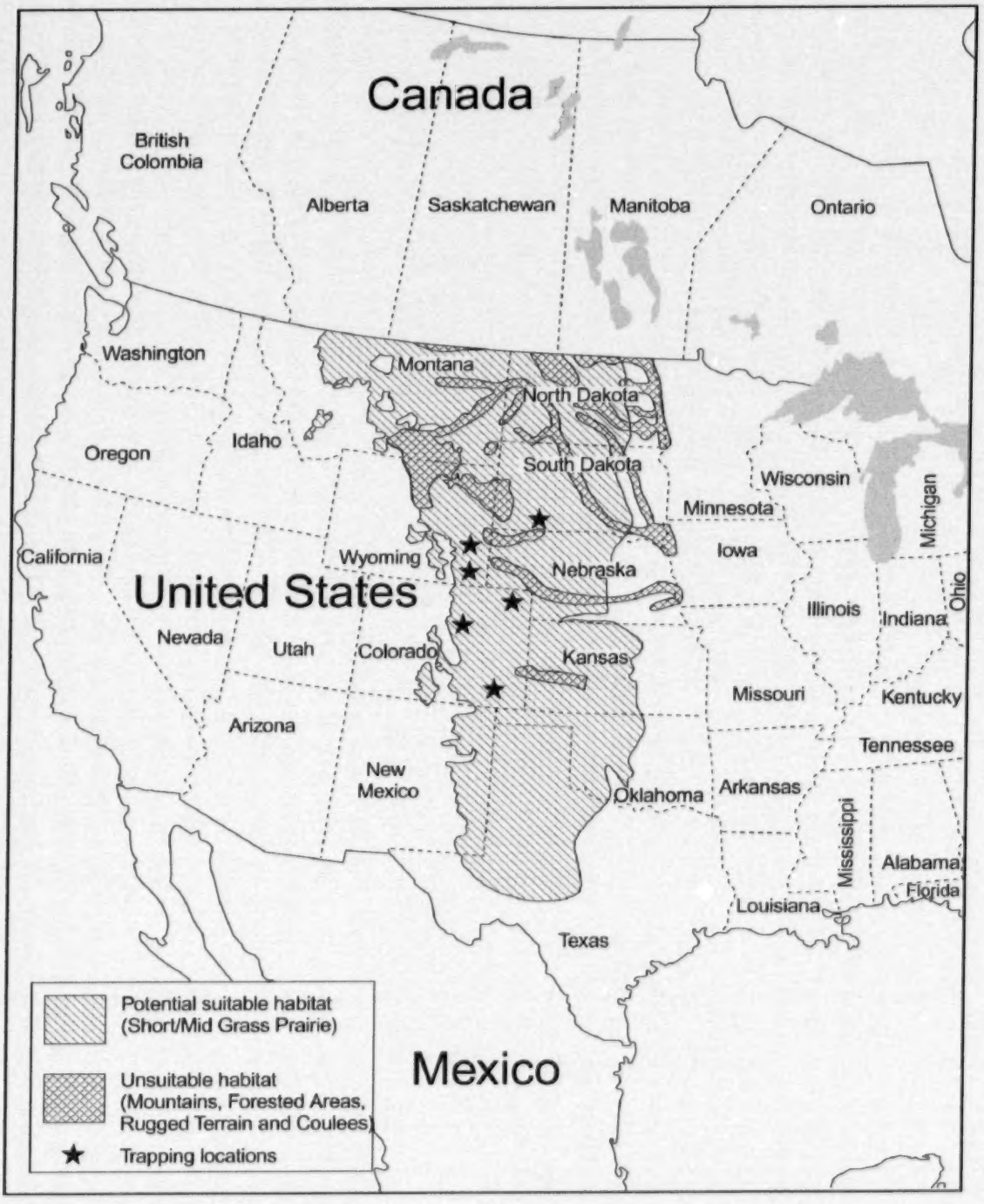


Figure 3. A map indicating distribution of potential swift fox range in the United States. Dispersal barriers, that could isolate populations and prevent gene flow, are shown stippled. Also indicated are trapping sites from which swift foxes were obtained for the Canadian re-introduction program.

Canadian distribution

Historical - to the 1930's

Historically, swift fox were present in southern Alberta (north to the 53rd parallel - Soper 1964), southern Saskatchewan and possibly in south-western Manitoba (Pattimore, 1985). The last confirmed specimen in Canada was taken in 1928, near Govenlock, Saskatchewan, 14 km east of the Alberta/Saskatchewan border and 28 km north of the U.S. border. An unconfirmed record was reported by Looman in 1972.

Current - 1983 to 1997

Since introductions began in 1983, the swift fox range in Canada has been delineated by Carbyn (1996) and was updated by Cotterill (1997b). None of the previous maps included areas of dispersal. Figure 4 incorporates information on suitable and unsuitable habitat dispersal locations and core areas, respectively. This map incorporates information available to date, on an approximation of swift fox habitat as determined from GIS mapping on a pixel of 1 km by 1 km. Core areas are identified as Core area 1 (Lost River Ranch - Border area) and Core area 2 (Grasslands National Park - Wood Mountain area). The land-cover information used in Figure 4 is based on National Oceanic and Atmospheric Administration (NOAA), Advanced Very High Resolution Radiometer (AVHRR) satellite imagery that was taken during the summers from 1988 and 1991. The imagery was classified by the Manitoba Remote Sensing Centre into broad landcover types at a resolution of 1 kilometre. The classified land-cover map was imported into Arcview software and converted into polygon format. The Arcview files were used to calculate the area of interest in this report and for illustration purposes.

It would be a misconception, and a misrepresentation of facts, if the current "potential range" is accepted as the "present range" of swift foxes in Canada and in the United States. There are vast spaces outlined in Figures 3 and 4 that likely do not have swift foxes at the present time. The challenge in future, is to evaluate the suitability of these areas for swift foxes and, if warranted, continue releases at these sites. Alternatively, abilities of foxes to disperse to these sites from core population areas, could be investigated.

The current population distribution in Canada and adjacent Montana is the result of an ambitious 14 year re-introduction program (Schroeder 1982; Russell 1983; Reynolds 1983, a, b; Russell *et al.*, 1984; Russell and Scotter 1984; Scott-Brown and Reynolds 1984; Scott-Brown and Herrero 1985; Herrero and Mamo 1987; Herrero *et al.*, 1989; Mamo 1987; Mamo 1988; Mamo 1994, a, b, c; Mamo 1995; Mamo *et al.*, 1990; Mamo and Herrero 1987; Mamo and Sturgess 1991; Carbyn 1986; Carbyn and Schroeder 1987; Carbyn 1990; Carbyn 1996; Carbyn and Killaby 1989; Carbyn *et al.*, 1993; Carbyn *et al.*, 1994; Brechtel *et al.*, 1993; Brechtel *et al.*, 1994; Brechtel *et al.*, 1996; Hjertaas 1994; Fisher 1993; Harris and McAdam 1994; Cotterill 1997 a, b; Taggart 1994; Moehrenschlager 1994; Smeeton 1994; Smeeton 1996).

The suspected swift fox range for 1997 was defined by information obtained from sites of releases, dispersal, telemetry locations, casual observations, road kills and monitoring of collared animals during a number of studies (Mamo 1994; Pruss 1994; Carbyn *et al.*, 1994). The core areas under consideration in Canada extends west of Manyberries, Alberta to east of Grasslands National Park in Saskatchewan and includes all or part of 108 townships.

A summary of the areas illustrated in Figure 4 is shown below. This is a first approximation of native prairie habitat found in core areas 1 and 2 and in peripheral areas in Alberta and Saskatchewan. Data requires further investigation.

	Total land Area	**Total native prairie**	**%**
Core 1 -	5,400 km^2	5,100 km^2	94%
Core 2-	4,200 km^2	3,400 km^2	81%
Periphery-	45,400 km^2	24,200 km^2	53%

The areas outlined in white (Fig. 4) contain some lands that are likely suitable habitat for swift fox while areas in gray are cultivated lands. The map does indicate the potential range in which subpopulations could exist within a larger metapopulation. The extent to which movements between sub-populations will occur depends on the ability of swift foxes to disperse, the nature of the areas in between sub-populations and the distances between suitable areas.

Canadian reintroduction program

The repatriation of the swift fox was due solely to the reintroduction program. It is inconceivable that foxes could have survived previous to the reintroductions in "pockets" without detection. Rumours did abound of the possible survivors, but such reports remained unsubstantiated, despite the fact that as recently as 1970 it was still believed that swift foxes occurred in very low numbers in their former ranges on the Canadian prairies (Novakowski 1970).

Foxes are vulnerable to trapping. It is a virtual impossibility that from 1928 (year of last official record) to 1983 (year of first official releases) - a span of 55 years - they could have remained undetected where trapping occurred. Clearly the reintroduction program carried out from 1983 to 1997 brought back this small carnivore to some areas of former abundance in southern Alberta, southern Saskatchewan and northern Montana. In 1983 the first official releases took place, however, this was not the first release. Prior to any formal activities, one private zoo from Edmonton had released 4 foxes into the Grasslands National Park area in 1976. Although highly publicized through a television program, this release was an unofficial one (Al Oeming pers. comm.) It is unlikely that a release of these 4 animals resulted in the establishment of a population.

The subsequent process of returning the species to its former range was a lengthy one. The first initiatives for captive breeding were at Calgary Zoo and Alberta Game Park (Polar Park), Edmonton, during the 1960's. The Alberta Game Farm foxes originated from Utah and were first bred in Alberta in 1961 (Al Oeming pers. comm.). Much of the leadership in captive breeding subsequently was through the Cochrane Wildlife Reserve (previously known as the Wildlife Reserve of Western Canada). A vixen (possibly two, the record is not clear) from the Alberta Game Park was given to the Cochrane Wildlife Reserve in 1976 (Smeeton 1984). Cochrane imported two pairs of foxes in 1972. These beginnings grew into a major program involving four federal/provincial agencies and six non-government organizations. The Canadian Wildlife Service (CWS) officially became involved in 1978, when COSEWIC (Committee on the Status of Endangered Wildlife in Canada) classified the species as "extirpated" (Russell and Zendran 1983).

From 1984 to 1989 the project was guided by a Technical Committee. In April 1989 the Technical Committee was replaced by the National Swift fox Recovery Team under RENEW (Recovery of Nationally Endangered Wildlife). The team initially consisted of representation from Alberta, CWS, Saskatchewan and University of Calgary, Faculty of Environmental Design. In 1993 the Calgary Zoo was also represented on the Recovery Team and in 1994 the Cochrane Wildlife Reserve, Edmonton Valley Zoo, Swift Fox Conservation Society and Parks Canada were added to the team, while the involvement of the University of Calgary and Calgary Zoo was terminated. Through very effective programs, the Cochrane facility has been able to generate impressive financial backing for captive breeding of foxes. The swift fox stud book was initially kept by the Calgary Zoo and reverted to the management of the Cochrane Wildlife Reserve in 1994. By 1997 the Cochrane Wildlife Reserve had changed its name to the Cochrane Ecological Institute, and ownership of the foxes was transferred from CWS to that facility. Prior to 1985 (from 1973-1985) the Smeeton family owned the captive foxes held on their ranch.

Because of the unique history and evolution of the program through different stages, the project, from its inception, was not based on an approved recovery plan. It developed from private initiatives (1961 and 1973), to a university project (1977) with some governmental support, to an interagency co-operative program (1984). Letters of agreement between provincial and federal governments had expired by 1989 and were renewed to 31 March 1994 and March 1997 respectively. Documents which initially placed the program into perspective, were a student thesis and reports of CWS projects done through the University of Calgary (Carlington 1978; Carlington 1980; Russell and Zendran 1983; Reynolds 1983; Schroeder 1985; Carbyn and Schroeder 1987).

A considerable amount of field work had been carried out by 1989. However, a general framework for operation was still lacking. The newly appointed Recovery Team set out to develop options and a management strategy. Without the lengthy trial and error period, none of the information we had on the responses of the foxes to different release techniques and to different environmental conditions, would have been available. When the Recovery Team was established in April 1989, it had available to it

a wealth of information upon which to build a program. A schedule was set and maintained throughout. In a series of meetings in 1989, the then newly formed Recovery Team presented management authorities with three options. After reviews by the Director, CWS, Western and Northern Region, the Director, Wildlife Branch, Alberta Fish and Wildlife, and the Director, Wildlife Branch Saskatchewan, a program was approved in 1992, and the appropriate funds allocated for extension of the program.

The overall objective was to first determine if reintroduction of the species into the Canadian prairies was feasible and, if so, to recommend whether or not a full scale recovery program was possible. The renewed efforts (beginning in 1989) outlined 3 initiatives: 1) using more wild captured foxes for hard releases; 2) releasing foxes in spring and comparing results with fall releases; 3) diversify locations, choosing wetter sites as a hedge against drought.

The measures of success for the 3 year program were identified. These were set by establishing minimum criteria, namely that on one release area, 15% or more of the animals released survive for at least one year in two out of three years; and that the annual recruitment of the surviving population should offset annual mortality in each year on at least one of four release sites.

By 1992, it was obvious that it was feasible to reintroduce the species (Brechtel *et al.*, 1993) and in order to maintain the momentum a further 5-year program (to 1997) was to be carried out. Specific directions were for the Recovery Team to prepare a 5-year Recovery Plan which was to include several key elements:

1. Continuation of releases of swift foxes for a further 5 years (1992 to 1997).
2. Monitoring of the wild population to guide future releases and assess program success.
3. Importation of swift foxes from Wyoming for release to the wild in Canada.
4. Continuation of captive-breeding, provided that breeding facilities can finance their own operation without direct government agency support.
5. Minimizing the number of captive foxes requiring long-term care after the program ends. All breeding foxes were to be released before they reached five years of age.
6. Provincial agencies to lead the release and monitoring programs, the Canadian Wildlife Service to lead sourceing of swift foxes from Wyoming and from captive-breeding facilities.
7. The Canadian Wildlife Service was to be the lead agency in developing research projects designed to evaluate the habitat requirements, survival and ecology of swift foxes in the northern extremity of their range.

Releases using both wild-captured (U.S. foxes) and captive-raised foxes continued from 1993 to 1997 with the exceptions of 1992 and 1993, when only captive-raised foxes were released. Three significant events dominated this period of time. Starting in 1994, research programs involving the Canadian Wildlife Service, the University of Oxford (Oxford, England) and the University of Alberta (Department of Renewable Resources) were carried out in the core areas of the current range. Prior to 1994,

feasibility plans and research were also conducted through the Faculty of Environmental Design, University of Calgary (Carlington 1980, Reynolds 1983a, Schroeder 1985, Pruss 1994). The Canadian Wildlife Service continued to provide major portions of funding from A-base sources and provided vehicles, equipment and accommodation in the field for all studies. Secondly, a detailed multi-agency survey of the numbers of foxes was carried out in the winter of 1996/97 (Cotterill, 1997a). This survey involved all government agencies and others and was very much a co-operative effort. Thirdly, the ownership of the captive colony of foxes at Cochrane was passed on from the Canadian Wildlife Service to the Cochrane Ecological Institute in June 1997. Several significant research efforts were carried out on captive foxes at the Cochrane Ecological Institute. These resulted in a study by E. Teeling (M.Sc., 1996, University of Edinburgh) and a study by S. Bremner (M.Sc., 1997, University of Edinburgh).

Soft and hard releases

The soft release method emphasized placing paired foxes into pens in the field during the fall, wintering them at these locations and releasing family groups in the following spring/summer. In the hard release program, foxes were transported from the captive facilities and released into the wild without prior conditioning in field pens (Carbyn *et al.*, 1994). From 1983 to the fall of 1987 all releases of captive bred foxes had involved the "soft release" method. The number of pairs of foxes released in the soft release program are summarized in Table 1. The total number of foxes released (adults plus offspring) was 137 foxes. In a sample of 200 foxes (45 soft released and 155 hard released foxes), survival to 6 months was 55% and 34% respectively; to 12 months it was 31% and 17% and by 24 months it evened out to 13% and 12% respectively.

The soft release program was discontinued because it was labour intensive, costly and provided fewer foxes than the hard release program. Fall releases were carried out from late August to October, when the young were thought to normally disperse, although more recent evidence (A. Moehrenschlager *et al.* in prep.) seems to indicate that dispersal may be less prevalent than previously thought at this time.

Table 1. Number of pairs of foxes placed in field pens in southern Saskatchewan and Alberta from 1983 to 1987 resulting in the release of 137 foxes (78 adults and 59 young born in the pens) during the soft releases

Year	Saskatchewan	Alberta
1983	Nil	6
1984	5	6
1985	5	6
1986	5	6

After 1987, all releases of captive-raised and wild-caught foxes used the hard release technique (Table 2). A breakdown as to foxes released in the West Block and the East Block within Grasslands National Park is summarized in Table 3.

Table 2. Summary of swift fox releases to reintroduce fox populations into southern Canada in a reintroduction project involving the hard release technique

Year/Season of Release	Alta./Sask. Border		Wood Mountain/ Grasslands Nat'l Park		Milk River Ridge	
	# Released	# Collared[1]	# Released	# Collared	# Released	# Collared
Summer 1972	-	-	2	-	-	-
Fall 1987	57	18	-	-	-	-
Fall 1988	53	12	-	-	-	-
Spring 1989	-	-	-	-	28	14
Fall 1989	35	13	-	-	33	13
Spring 1990	28	27	-	-	-	-
Fall 1990	38	0	51	20	-	-
Spring 1991	-	-	29	28	-	-
Fall 1991	35	0	46	10	-	-
Fall 1992	-	-	87	-	-	-
Fall 1993	15	-	35	-	-	-
Fall 1994	43	11	19	-	-	-
Fall 1995	21	11	34	-	-	-
Fall 1996	17	7	37	-	-	-
Fall 1997	-	-	62	-	-	-
Total	342	99	402	58	61	27
Total hard releases						805

[1]"Collared" foxes lists those which had radio transmitter collars attached in order to track survival and distribution.

Table 3. Number of foxes released in the East Block and West Block of Grasslands National Park, Saskatchewan

	East Block/Wood Mountain		West Block	
Year	**Captive-raised**	**Translocated**	**Captive-raised**	**Translocated**
1990	51		-	-
1991	61[1]	14	0	-
1992	16		38	-
1993	11		24	-
1994	9		10	-
1995	12	6	16	-
1996	22	-	7	-
1997	32	1	26	-
Total	214	21	121	-

[1]Four of these foxes were held in captivity after capture in the U.S.A. in 1988 and designated as captive foxes in this table, as they had been conditioned to confinement.

Wild-capture program

The Canadian re-introduction program depended on both captive-raised and wild-born foxes. It was necessary to import foxes from the U.S. in order to have breeding foxes in captive facilities. The Alberta Game Farm, near Edmonton was the first Canadian facility to raise swift foxes during the early to late 1960's.

Since 1983, the Wildlife Reserve of Western Canada, near Cochrane, Alberta, was the main source of captive-raised foxes. A steady supply of captive-raised foxes provided the nucleus for the reintroduction program. Other facilities involved at a later stage were the Calgary Zoo (1983-1994), Moose Jaw Wild Animal Park (1984-1995), and Valley Zoo in Edmonton (1989-1997). There are two other Canadian facilities (Kamloops Zoo and Forestry Farm Zoo in Saskatoon) that hold swift foxes for display purposes. In 1996 there were 16 Canadian zoos listed as accredited by the Canadian Association of Zoological Parks and Aquariums (Dave Leeb pers. comm.), which increases the potential for future display of captive swift foxes for public education programs.

The total number of foxes imported for the official program, from the United States is shown in Table 4. Over the years, there was a lively debate over the merits of releasing captive-raised foxes versus wild-caught foxes. Initial hard release efforts (1983 to 1989) used wild-caught foxes in smaller proportion (18 out of 344) than in later years (66 out of 535). Overall ratio was 84 wild-captured to 795 captive-raised or 1:10. These figures do not include foxes born in soft release pens.

One component of the debate has centred on the negative aspects of removing animals from the wild, thus reducing numbers world-wide. This is relevant, if overall numbers are low, but less relevant if the species still is widely distributed and existing at high densities in portions of its range. Releasing captive-bred stock adds to the world's population while translocation does not. Capturing was carried out in the wild, without the benefit of population estimates to determine the impacts of removal of foxes from established populations. This may become an important consideration, if the wild capture of foxes is to continue for re-introduction purposes.

Table 4. Summary of number of foxes imported from 1973 to 1996 for the Canadian reintroduction program. These foxes were used for both captive breeding and releases

Year	Number of foxes	Location
1973	4	Colorado (Golden County)
1980	7	South Dakota (Pierre)
1980	5	Colorado (Weld County)
1981	5	South Dakota (Pierre)
1984	9	Colorado (Weld County)
1985	9	Colorado (Lincoln County)
1986	11	Wyoming (Laramie County)
1987	2	Colorado (Las Animas)
1988	11	Colorado (Las Animas)
1990	19	Wyoming (Laramie County)
1991	22	Wyoming (Laramie County)
1994	20	Wyoming (Laramie County)
1995	20	Wyoming (Laramie County)
1996	7	Wyoming (Laramie County)

POPULATION SIZE AND TRENDS

Alberta

In Alberta, swift foxes were released at 2 sites - the Alberta/ Saskatchewan border (including the Lost River Ranch area) and the Milk River Ridge area. Due to problems with rabies, the latter site was abandoned soon after initial releases in 1989.

An intensive population census in 1996/97 resulted in the first detailed estimates of the overall success of the re-introduction program. Numbers were obtained for the Alberta/Saskatchewan border area and for Grasslands National Park area. In the border portion of its range there were approximately 192 animals (95% confidence interval 93-346). This result was obtained from trapping along random transects placed through the core portion of suspected swift fox range (Cotterill, 1997a). The apparent population had increased from the 1994 survey, when numbers were estimated between 100-135 foxes (Mamo 1994a).

Density and population estimates in the 1996/97 survey were influenced by the home range size used in the calculations. Home range size were based on radio-tracking information obtained from 1-2 year periods. Home range sizes in the 3-month census period are likely smaller, hence the population estimates are affected. Numbers may have been underestimated as a result of poor weather conditions. Finally, not all areas likely to have foxes were covered. For example, foxes that dispersed from Canada to the United States are not included (Cotterill, 1997a).

Wild-born foxes in the 1997 surveys formed the greater proportion of the population. The proportion of wild-born foxes to released foxes (both captive-born and wild-captured) during the 1996/97 census was greater (Cotterill 1997a) than in the studies carried out in 1990/91 (Carbyn *et al.*, 1994) but less than in the census carried out by Mamo in 1994 (Mamo 1994c). The large proportion of wild-born foxes, and presence of both older and juvenile wild-born, may be an indication that a self-sustaining population has been successfully established.

In addition to the core population within the Alberta range, several other areas (Figure 4) have been known to contain swift foxes. These are in the Bow Island and Brooks areas. One dispersal of about 200 km has been documented for a radio-collared fox; another swift fox (animal was not marked) had been trapped 250 km from the closest release site (CWS files). Since it was an unmarked animal, nothing can be said about its origin.

Saskatchewan

Two areas (East Block/West Block) were chosen as release sites in central Saskatchewan. The sites are approximately 60 km apart. Distances from the Alberta/Saskatchewan border populations to Grasslands National Park, East Block and West Block, are approximately 248 and 185 km respectively.

The total number of foxes present in the Wood Mountain area in the 1996/97 winter survey, was about half of that along the Alberta/Saskatchewan Border (Cotterill 1997a). Seven foxes were captured in the East Block and 1 fox in the West Block. Number of foxes released in east/west blocks to 1996 were approximately 245 and 121 respectively (exact numbers not known). The estimated population in the Wood Mountain area (Saskatchewan only; excluding Montana), was set at 87 animals (Cotterill 1997a).

Manitoba

Swift foxes were not released in Manitoba as prairies in that province are not extensive enough to warrant a reintroduction program. It is questionable if the species ever existed in significant numbers in this area (Pattimore 1985).

One remarkable observation was made on 19 April, 1997 by Peter Sawatzky, resident of Glenboro, Manitoba. On only that one day he and his son watched a swift fox at a den. The den was in atypical swift fox habitat and on the edge of an agricultural field. This would have been a questionable record, had the observer not been a naturalist, and had there not been quality photographic evidence available to verify the identity of the fox.

There is some question as to how the swift fox reached that location. Natural dispersal from the nearest known Canadian population would mean a dispersal distance of 700 or more kilometres. Much of the intervening space is highly modified agricultural land and, to a lesser extent, wooded areas as well. Although it is not known where the nearest U.S. population may have been, neither distance nor habitat suitability makes it likely that the fox had dispersed northward. Major stretches of agricultural areas and incised riparian habitat intervened. The closest record due south appears to be of a swift fox seen in 1990 in the Missouri Grasslands area in North Dakota, some 225 km from the Canadian Border.

Population structure

Age/sex structure

Two sources of information provided data on population structure. These are the 1996/97 winter survey (Cotterill 1997a) and studies by Moehrenschlager and Michie (1994-1998). Population structure information gives an indication of the "robustness" of the reintroduction, trends and survivorship.

During the winter census, the ratio of young to adults was equal. More males than females were caught (20 to 12). The sex ratio amongst adults was even but more than twice as many juvenile male foxes were captured than females (11 to 5). Of the 32 foxes captured 26 were wild-born, four were captive-reared and two were transplanted from Wyoming. Eight wild-born foxes had been previously marked and of the 18 unmarked, 7 were adults and 11 juveniles (Cotterill 1997a).

In the Alberta/Saskatchewan border area a similar number of adults (13) and juveniles (11) were trapped and both adult and juvenile classes were characterized by an equal sex ratio (Cotterill 1997a). In contrast, the Wood Mountain ratio was noticeably higher for males than females (7 to 1).

Trapping success

A calibration-based census technique was designed to circumvent logistical constraints associated with winter fox trapping. The calibration-based method used current Canadian swift fox home range data to determine: 1) the area sampled by a series of six live-traps set one kilometre apart; and, 2) a trapping success correction factor based on the success of the census method in capturing marked swift foxes within known home ranges. This correction factor was used to adjust and interpret trapping results throughout the census area. (Cotterill 1997a).

Fifty-eight townships were surveyed during the census, representing approximately 54% of the suspected core swift fox ranges in Canada. Six box traps were each placed one kilometre apart along a trap line within each surveyed township. Townships were surveyed for three nights (56), while two townships were censused for two nights, resulting in a sampling effort of 1,032 trap nights. Winter weather conditions were exceptionally severe, yet the overall trapping success was encouraging. Trapping success provided a measure of the occurrence and relative density of animal populations in different areas. The overall trapping success was 4.9%[1]. If only new captures are considered the success rate was 3.1%.

Thirty-two individual foxes were trapped and a total of 51 captures, including recaptures, were recorded. Trapping success was 4.9% per trap night, and 3.1% per trap night for one-time captures. Four of 14 "calibration" foxes were trapped, resulting in a correction factor of 3.5. Therefore, every fox captured represented 3.5 foxes in the area surveyed.

In the census, trapping success per sample block within a township ranged from 0 to 17% with a range of 0 to 3 foxes caught per trap line during a 3-night period. Seventy five per cent of the foxes captured in the census were within 50 kilometres north, east and west of the Alberta/Saskatchewan/Montana border junction (Cotterill 1997a).

The correction factor was also expressed in terms of 29% trapping success. Ten non-calibration animals were also captured in the calibration townships (Cotterill 1997a). It was highly fortuitous that the above survey results were integrated with the research program carried out at the time by Axel/Cynthia Moehrenschlager and data collected by Jasper Michie and other field workers.

[1]51/1,032 trapnights

Legal protection

Now that the foxes have become established, a framework of protection is important. Below is a summary of the 1998 regulations.[2]

Saskatchewan

The swift fox is identified in the Saskatchewan Wildlife Act, under the Wild Species at Risk Regulations as an endangered species (gazetted on 27 January 1999). Specifically under Section 52 (1), part (V) of the Wildlife Act, 1997, it is given full protection on private, provincial and federal lands and it is forbidden to:

(a) kill, injure, possess, disturb, take, capture, harvest, genetically manipulate or interfere with, or attempt to do any of those things to swift foxes.
(b) export or cause to be exported from Saskatchewan any wild species at risk.
(c) traffic in any wild species at risk.

Any person who contravenes clause 52(1) is guilty of an offence and liable on summary conviction.

In the case of an individual:

i) for a first time offence to a fine ranging from not less than $10,000 to $100,000, to imprisonment for a period not exceeding two years, less a day, or both.
ii) for a second or subsequent offence, to fines ranging from $20,000 to $200,000, to imprisonment.

In the case of a corporation:

i) for a first offence, to fines ranging between $10,000 and $500,000.
ii) for a second or subsequent offence, to fines ranging from $20,000 to $1,000,000.

Presently the intent of the legislation is not to prosecute landowners, or other individuals, who unknowingly destroy listed species on their habitat, but to raise awareness among landowners, resource users, the general public and government agencies on the identification and presence of listed species.

Section 5(1) of the Wild Species at Risk Regulations (1999) provides protection for swift fox dens.

Section 6(3) of the Wildlife Regulations (1981) provides additional protection, in that swift fox may not be killed by landowners or land occupants for the purpose of protecting property or livestock.

---

[2] updated to 1999.

Alberta

The swift fox is identified in Schedule 6 of the General Wildlife Regulation (AR 143/97) under the Wildlife Act as an Endangered Animal. As an endangered animal it is given full protection. This includes general prohibitions against hunting (meaning to shoot at, harass or worry, chase, pursue, capture or wilfully injure or kill or attempt to do so, etc.), trapping and trafficking (meaning to sell, buy, barter, solicit or trade or offer to do so).

Section 38(1) of the Wildlife Act (1984) states that "A person shall not wilfully molest, disturb or destroy a house, nest or den of wildlife prescribed by the Minister in areas and at times prescribed by the Minister." Section 96(a)(i) of the Wildlife Regulation states that Section 38(1) of the Act applies to "endangered animals throughout Alberta throughout the year".

Section 10(1) of the Wildlife Act states that "Subject to this section, the property in all live wildlife in Alberta is vested in the Crown." Section 10(3) goes on to indicate that "... the property in wildlife that ceases to be held in captivity reverts to the Crown."

Section 11(1) states that "After the death in Alberta of wildlife belonging to the Crown, the property in it remains in the Crown unless the Minister transfers it to another person..." Section 92(4) states that a person who is convicted of an offence of hunting or trafficking of an endangered animal "...is liable to a fine of not more than $100,000, or to imprisonment for a term of not more than 6 months, or both."

Montana

The species is a furbearer solely under state authority. This means, with a valid license, the species can be trapped. Under state law, persons convicted of knowingly taking, possessing or transporting furbearers or pelts in violation of the rules or laws, shall be fined not less than $50 or more than $1000, imprisoned in the county jail for not more than 6 months, or both. In addition, such person shall forfeit his privilege to hunt, fish or trap for not less than 24 months. Civil restitution from $100 to $500 may be assessed for each illegal animal or pelt.

The swift fox is not presently a federally listed species under the United States Federal *Endangered Species Act (ESA)*, so none of the laws or penalties associated with this federal Act would apply. However, if the swift fox becomes a listed species under the ESA, two different scenarios could develop:

(1) Accidental taking of an animal could be allowed if a special 4(d) rule is developed with the states without penalties.

(2) Without a special rule, that persons convicted of illegal take would be subject to fines up to $20,000 and/or 2 years in jail.

Summary

In summary, the swift fox is provided with legal protection in Alberta, Saskatchewan, to a lesser extent, Montana, and significant penalties may be levied for the hunting or trafficking of this species. Despite legal protection, there are a significant number of cases of trapping (accidental catches), poisoning (intended for coyotes) and hunting (mistaken identification), to warrant concern. Swift fox dens are also protected throughout Alberta and Saskatchewan.

HABITAT

General description

Swift foxes typically prefer short or mixed grass prairie with flat to rolling terrain and sparse vegetation. Such conditions appear to provide optimum opportunities, in face of predators, for mobility and visibility. The fox likely chooses areas with long sight-lines, therefore avoiding vegetation or topographic features such as canyons, steep hills, dense shrub, forests and coulees (Whitaker-Hoagland, 1997). Vegetation of preferred areas usually is sparse and short (25 cm or less in height). At times, swift foxes in the United States have also been present in areas considered somewhat non-typical such as Badland-like areas in Wyoming (Lindberg 1986; Wooley *et al.*, 1995). Sandhills of Nebraska (Blus *et al.*, 1967) pinon-juniper habitat in Colorado (Covell 1992), cultivated areas adjacent to shortgrass prairies (Floyd and Stromberg 1981) or even in cultivated fields (Kilgore 1969; Cutler 1958; Jackson 1997).

In Canada and in the northern United States, swift foxes favour native grasslands over cultivated farmlands. The reasons for this are not completely understood. Food availability may be important. In northern areas pasture sage (*Artemisia frigida*) and grasses, such as blue gramma (*Bouteloua gracilis*), spear grass (*Stipa comata*), and fescue (*Festuca*, spp.) are the dominant vegetation in these areas.

In addition to native prairie, several other habitat features may be important to swift fox populations. Unlike other canids, swift foxes use multiple den sites year round for shelter and rearing young, and to escape predators. The presence of fossorial animals, such as badgers (*Taxidea taxus*) and ground squirrels (*Spermophilus spp.*), is therefore desirable, as swift foxes will modify existing burrows. If the soil type is suitable for excavation, swift foxes will dig dens themselves. Dens are usually located in well-drained sites. Permanent water bodies and low predator abundance also enhance habitat suitability for swift fox (Mamo 1994b).

Habitat destruction

Habitat loss to swift foxes can include outright destruction (e.g. ploughing) or alternation (e.g. grazing regimes) and modification of components (keystone species) within the system. Destruction involves the removal of habitat (native prairies), while

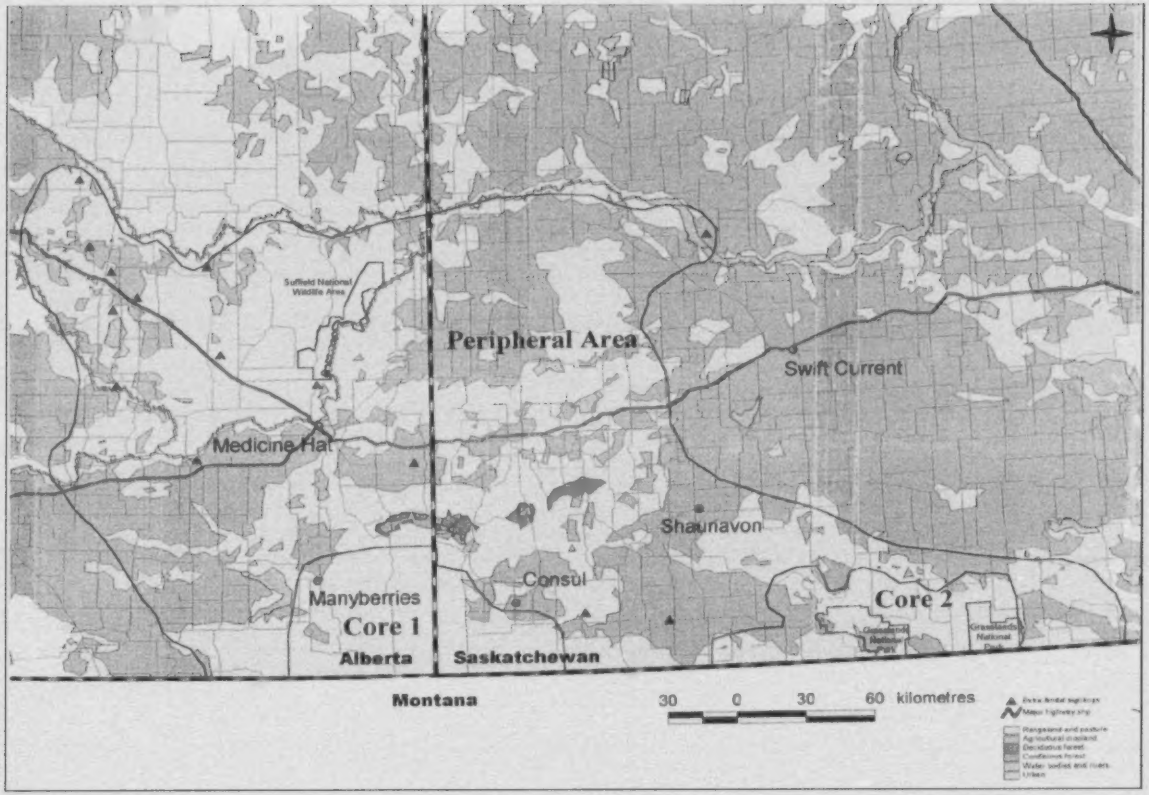


Figure 4. Map showing approximate distribution of swift foxes in Canada. It includes information from surveys and from records of animals that have dispersed from the core reintroduction sites along the Alberta/Saskatchewan border and the Grasslands National Park areas.

modification changes the biological components and energy flow within the system. A century and a half of European settlement on the Canadian prairies has left a marked imprint on the landscape. Agriculture has transformed more than 80% of the native Canadian prairie landscape (Gauthier and Patino 1993). American native prairies, likewise, have been extensively modified (Licht 1997). This resulted in massive habitat degradation and loss to the swift foxes located at the northern portion of their range in North America.

In southern Saskatchewan (core areas of the former distribution) for example, 60% of the grasslands were already under cultivation by 1931 (the beginning of an era of major natural droughts), Rowe and Coupland 1984. Today about 47% of Saskatchewan's total land base is farmland and about 24% is productive cropland (Gauthier and Patino 1993).

Another cause of habitat loss is the change from ranching (grazing) lands to cultivation. Every 5th year, Agriculture Canada measures the land use categories of "improved" and "unimproved" pasture. Those data show loss of pasture habitat. Burrowing Owls (*Speotyto cunicularia*), whose habitat requirements are somewhat similar to swift foxes, have been used as an "indicator species" for this habitat loss (Wellicome and Haug 1995). In the case of Burrowing Owl habitat (as defined by Wedgwood 1978), the amount of total farm area allocated as pasture area within the owl's range from 1966 to 1991 decreased by about 8% in Alberta and 6% in Saskatchewan while croplands increased by about 15% in Alberta and 19% in Saskatchewan. The most drastic losses occurred between 1976 and 1986, a decade following peak prices for wheat. Progressive legislation was introduced in Saskatchewan, under the Wildlife Habitat and Protection Act, which prohibits the breaking of native grasslands on about 2 million hectares of crown lands in the grassland ecoregion.

We know that swift fox range in Canada, prior to the turn of the century, was greater than after that time (Soper 1964). Therefore, if we roughly equate pasture land in mixed-grass areas with swift fox habitat, then a starting point for likely habitat losses can be calculated, if total swift fox range is to be equated with present pasture land (cf. Telfer *et al.*, 1993). The pasture remaining today represents approximately 46% of the original habitat within the species' former range in Alberta and 26% in Saskatchewan. However, it is false to assume that all former rangelands were well suited for swift foxes. Areas with hilly terrain and heavy shrublands are classified as pasture but are not areas where swift foxes normally occur. Therefore, the pasture areas remaining today constitute only a small fraction of what once was swift fox habitat as much of the uplands, now in production, were likely better suited for foxes than the hilly terrain that survived cultivation.

Habitat degradation

Physical modification of grassland areas is not the only form of habitat destruction. Modification of biological composition can also affect the suitability of the area for

species. Cattle grazing, use of pesticides and herbicides and increase in prey that attract avian and mammalian predators all have impacts of varying magnitudes on the ecosystems. Swift foxes prefer areas with sparse vegetation, interspersed with sites that are suitable for small mammal survival. Grazing patterns by ungulates likely play an important role. Overgrazing by cattle, or undergrazing are activities that will have impacts on swift fox prey. Grazing by bison in pre-European settlement days likely resulted in different use patterns than with modern stocking rates of cattle. Distribution of small mammals is of importance to swift fox ecology. Vegetation cover influences species composition. For example, in one area T. Wellicome (in prep.) noted that meadow voles (*Microtus pennsylvaticus)* and prairie voles (*Microtus ochrogaster)* were present only in areas with undisturbed vegetative cover. Grazing impacts on vole numbers are not well understood. Grazing pressures in mixed-grass prairie has increased by one-third in Saskatchewan and one-half in Alberta between 1956 and 1976 (Coupland 1987).

Agricultural activities also led to the extirpation of wolves (*Canis lupus)* from the prairies which allowed coyotes to spread and increase in numbers (Sargeant *et al.*, 1993). Populations of other predators fluctuated as well, thus impacting on habitat availability for foxes. This applies to "meso predators" such as skunks (*Mephitus mephitus)*, red foxes (*Vulpes vulpes*) and badgers (*Taxidea taxus*) (Roast 1987, Violet 1987; Voigt and Berg 1987 and others).

Avian predator habitat was also influenced by settlement. Fire suppression and planting of shelter belts and trees around homesteads all contributed to increasing nesting opportunities for Great Horned Owls (*Bubo virginianus)* and various species of hawks and eagles (Schmutz *et al.*, 1980; Licht 1997). Badger numbers were negatively affected by man through direct persecution. Loss of badgers has mixed impacts. It reduces predation but also may affect availability of escape terrain. Swift foxes use badger burrows as dens (Pruss 1994). The exact nature and importance of this is not clear. Dens with larger den entrance openings may not provide safe shelter for swift foxes against predators.

Criss-crossing of highways and roads through the prairie landscape creates a fragmentation that did not exist when swift foxes were more common under pristine conditions. Swift foxes are killed due to collision with vehicles. It may be possible that foxes spend more time along roads, if the prey base is greater along ditches than in upland areas. Possibly, swift foxes may spend more time along roads if they are trying to avoid predation from coyotes. Ranchers are known to shoot coyotes on sight, whenever possible. Such actions appear to have a positive impact on swift fox survival, although ecological links may be more complex than it might first appear. It is presumed that, as the number of roads and vehicles increases, there will be an increased likelihood that foxes would be killed by vehicles. Increase over time, of fox fatalities from vehicles, may also be a function of increasing fox populations.

Habitat fragmentation

Approximately 24% of the mixed-grass prairie zone in Canada remains uncultivated (Prairie Conservation Action Plan 1994). Even though a substantial proportion of the southern prairies still remain as grasslands, those areas are also affected by man. Conversion of native prairies to agricultural lands, building of highways, roads, oil and gas well sites and pipelines, service trails, and the presence of towns and urban areas have all contributed to habitat fragmentation.

Despite fragmentation, several large expanses of native grasslands exist in both southern Alberta, and south-western Saskatchewan. Some of those areas are crown lands, others private rangelands. Additional conversion of rangelands to cropland (cultivation) would destroy remnant native grasslands. Conversion of privately-owned rangelands to croplands is largely driven by a market economy. Should government financial incentives for cultivating croplands increase, or prices of grain or other agricultural products increase, conversion of native grasslands would occur, as in the past, and will inevitably result in further habitat destruction for swift foxes.

Oil and natural gas exploration fragment natural prairies to a lesser extent. Some studies have shown that swift foxes can tolerate considerable disturbance. Presence of roads may have both positive and negative effects. On the positive side, prey abundance for swift foxes may increase in the ditches along roads. However, increased mortality due to road kills, accidental shooting and trapping may also be a negative factor on swift fox survival.

GENERAL BIOLOGY

Morphology, description and taxonomy

The swift fox is the smallest of the North American canids (Egoscue 1979) and one of 3 species belonging to the genus *Vulpes*. The animal is the size of a large house cat with measurements ranging around 840 mm (total length); 280 mm, tail, 30 mm, hind foot, and 80 mm, ear length. The black tip on its tail, and black around the muzzle, distinguishes swift foxes from young coyotes or light colour phased red foxes. Winter pelage is buffy gray with some red (orange tan) coloration in abdominal areas. Summer fur is short and more reddish. Average weight of adult males is about 2.5 to 3 kg, and females 2.0 to 2.4 kg, respectively. Body size of males is about 8% heavier than females (Egoscue 1979). Swift foxes have an elongated skull with small widely-spaced teeth. Skull sizes that have been recorded for Colorado foxes (males) were measured as 112 mm, zygomatic breadth (64 mm) and interorbital constriction (24 mm), post orbital constriction (23 mm).

The three members of the genus Vulpes in North America are red fox *(V. vulpes)*, kit fox (*V. macrotis*) and swift fox (*V. velox*). Kit and swift foxes are considered the "arid land" or prairie/desert fox complex. The exact taxonomic distinction between the two species has been under review (Samuel and Nelson 1982; Dragoo *et al.*, 1990; Mercure *et al.*, 1983; Wayne, in prep.)

The swift fox differs from the kit fox in appearance by a broader skull, shorter ears, shorter tail length and slightly larger body size. Swift fox are residents of grassland regions, while kit fox occupy the desert environments west of the Rocky Mountain Area and associated mountain ranges. A review of the subspecies designation was summarized by Knowles (Fauna West 1991). He noted that Merriam, an early taxonomist prone to excessive subspecies designations, described two subspecies, the northern swift fox (*Vulpes velox hebes*), and the southern swift fox (*Vulpes velox velox*) (Merriam 1902). This classification was the basis of a brief listing of the northern subspecies as an endangered species (U.S. Fish and Wildlife Service 1979 and 1982). The northern swift fox was delisted when it was decided that valid subspecies variation did not exist (Stromberg and Boyce 1986). However, those authors cautioned that there was significant geographic variation among the specimens examined and that this variation may reflect genetic differences. They advised that conservation efforts to restore swift foxes to former portions of their range consider this geographic variation. The issue precipitated a debate in the literature between Stromberg and Boyce, who critically reviewed the Canadian reintroduction program, and (Herrero *et al.*, 1986) who defended it. A similar study conducted by (Dragoo *et al.*, 1990) also concluded that the subspecific designation, as proposed by Merriam (1902), was not valid.

Hall (1981) suggests that the swift and kit foxes are conspecifics. Dragoo *et al.* (1990) present data to support this contention. They assessed the relationships of these two foxes by morphometric and protein-electrophoretic methods. In the latter case, they found genetic divergence to be negligible with a high degree of genetic similarity among all subspecies examined. Morphometric analysis were only able to distinguish between the swift and kit fox and not between any of the previously proposed subspecies. Dragoo *et al.*(1990) propose reclassifying the swift and kit foxes as a single species - *Vulpes velox* - with only two recognized subspecies - the swift fox, *Vulpes velox velox*, and the kit fox, *Vulpes velox macrotis*.

Diet and foraging behaviour

Earliest description of the food habits was from Baird, who noted that "mice and grasshoppers" were eaten (Baird 1858). We know from various studies that swift foxes opportunistically prey on a variety of food sources (Pruss 1994). A list of identified food items from material collected in Oklahoma included 13 species of mammals, 4 species of birds, one species each of amphibians and reptiles and 30 species of invertebrates (Kilgore 1969). Jack rabbits (*Lepus townsendii*) are the largest prey species in Canada. Ground squirrels (*Spermophilus* spp.) likely are seasonally very important. Black-tailed prairie dog distribution (*Cynomys ludovicianus*) in the Canadian prairies is very limited, therefore of no consequence to swift fox survival in most areas.

Current studies (Moehrenschlager, Michie and Moehrenschlager, in prep.) involve an analysis of scat samples collected on the Canadian prairies from 1994 to 1997. Results will be particularly important in identifying winter food habits in the northern extent of the range of the species. Work on small mammal availability in winter resulted in interesting data for 3 regions in which swift foxes have been released (Klausz 1997). Biomass values

in winter were low for upland, roadside and coulee areas. Foxes probably seek out appropriate micro-environments with concentrations of voles/mice and insects and vulnerable components (e.g. young hares) within the prairie ecosystem.

Much work needs to be carried out on the foraging behaviour of swift foxes in northern ranges. Swift foxes are largely nocturnal in winter. Onset of activity appears to be correlated with light (sunset) but varies with the temperature. It is not uncommon to see foxes sunning themselves at den entrances during cold, sunny days in winter. It is likely that foxes travel along predictable routes (fence lines; ridges, cattle trails, etc.) in foraging trips through their home ranges. Pruss (1994) found that during the spring/summer period, swift fox are active over extended periods during both the day and night. A total of 10 natal dens (5 per study season) were watched from May-August 1991-1992.

Northern swift foxes switch their food requirements from winter to summer based on availability. Young foxes in summer forage on grasshoppers. Similarly, foxes soon after release were seen to forage on insects. Adult foxes have been observed feeding young with ground squirrels. Ground squirrels and live grasshoppers are not available in the winter months.

Denning activities

Swift foxes are the most den-dependent of all canids in North America. Even though dens are used year round, the use of specific sites shifts (Chambers 1978; Hillman and Sharps 1978; Hines and Case 1991; Kilgore 1969).

On the Canadian prairies, all dens investigated were in native prairie. These sites provide clear views of the surroundings, which could be a hedge against predation. Pruss (1994) compared the location and physical characteristics of 32 occupied swift fox natal/rearing dens and 33 unoccupied (typically badger) burrows. A stepwise discriminant function analysis identified 5 potential discriminators between occupied and unoccupied sites (i.e. position on hill, height of new grass, distance to water, distance to roads and slope). Dimensions of den openings in South Dakota were an average 19 cm wide and 22 cm high (Hillman and Sharps 1978). Number of den entrances is greater for natal dens than for escape dens.

Mating systems, growth and reproduction

Females are monestrous, with oestrous occurring from late December to February. Swift foxes have a gestation period of about 55 days. The pups are born from mid-April to June (C. Smeeton pers. comm.), and weigh about 200 grams at two weeks of age (P. West pers. comm.). The pup's eyes and ears are open at about two weeks, and the pups are fully weaned by six weeks. They reach their adult weight by mid-summer (J. Creviston pers. comm.). Pups have a soft woolly coat for the first month, but later develop the adult pelage. Males reach sexual maturity before the end of their first year; however, not all of the first year vixens will breed.

Foxes usually mate for life in a monogamous relationship, but observations of some burrows containing one male and two females have been made (Nowak and Paradiso 1983; Covell 1992; Carbyn *et al.*, 1994). Covell also found one case of 3 females in association with one male. Observations, particularly during the mating season, of concurrent den sharing and home-range use was recorded by various investigators in the Lost River Ranch/Border area in southern Alberta and Saskatchewan (Carbyn *et al.*, 1994).

LIMITING FACTORS

Predation

The greatest limiting factor relates to the "robustness" of the species itself (Kitchen *et al.*, 1998). Swift foxes are small and vulnerable. In contrast coyotes have a much easier time surviving all the potential mortality factors in prairie ecosystems. Swift fox predators such as coyotes may kill and abandon victims. Alternatively, predators like eagles, coyotes, and badgers may kill and consume foxes.

Of 89 foxes found dead between 1983 and 1992, 34 were either known or suspected coyote kills (Carbyn *et al.*, 1994). Badgers accounted for 3 kills and 3 suspected kills. Known avian predation (golden eagle) accounted for 5 foxes and 2 were suspected avian kills.

In post-mortem examinations conducted by S. Black of the Calgary Zoo, 12 foxes (9 females, 3 males) out of 39 carcasses examined were killed by coyotes. Avian predation (Golden Eagle) accounted for 6 out of 39 (4 females, 2 males) and 1 out of 39 was a confirmed badger kill (S. Black pers. comm.). In 1997, a number of foxes were killed by eagles, and the kill rate that year was higher than that by coyotes (J. Michie, pers. comm.). More information will be required in the future to understand eagle migration and wintering patterns. The same applies to Snowy Owls and Great Horned Owls. Availability of prey is key to understanding the dynamics within the prairie ecosystem.

A new threat to swift fox survival may be the spread of red foxes. In all of the previous years, only rare sightings of a red fox were reported (Mamo, pers. comm.) for the Saskatchewan/Alberta border area. Since 1996 sightings of red foxes have increased (Carbyn, Michie, Moehrenschlager field notes). In some cases red foxes were moving into areas known to be frequented by swift foxes. Since this is apparently an evolving threat, there is a need to begin a study on red fox ecology and the potential impact on swift foxes, before red foxes become more widespread. If a similar pattern of increased red fox competition is to prevail, as in other areas (c.f. North Dakota; M. Sovada pers. comm.), we could expect a problem developing that may impact swift fox numbers in the future.

Collision with vehicles

From 1983 to 1992, 5 of 89 foxes killed were road kills (Carbyn *et al.*, 1994). Black (pers. comm.) noted that 8 out of 39 foxes necropsied were road kills. Out of the eight, 6 were pups and 2 were adults. Pups are particularly vulnerable if dens are close to highways. In San Joaquin Valley, California, 8% of deaths recorded on kit fox from 1980 to 1994 were as a result of road kills (Cypher pers. comm.).

Range management

The once common bison have been replaced within the last 125 years by cattle as grazers on the mixed grass prairies. Domestic livestock grazing patterns differ from those of native ungulates, resulting in different plant composition and carry over of duff on prairie soils. The reintroduction results to date, have shown that swift foxes have become established, and survive without the presence of bison. However, we do not know what effects different grazing pressures have on the availability of small mammals, particularly in winter. Little is known about the effects of range management on swift foxes, however, it is generally considered that foxes prefer grazed areas.

Pipelines

Knowledge from current radio-tracking studies is now being integrated into land use management decisions in Alberta (J. Taggart pers. comm.). Recent studies appear to indicate that pipeline construction may not be a major factor in swift fox survival, as long as physical destruction of dens does not occur (A. Moehrenschlager pers. comm.)

Guidelines for activity restrictions and disturbance near swift fox natal dens are currently under review by Alberta Natural Resources and Saskatchewan Environment and Resource Management. These guidelines recommend that a 200 m buffer zone around natal dens be set to exclude passive activity (photography, walking), in the breeding and pup-rearing period (15 February to 31 July). A 500 m buffer zone is recommended to exclude all industrial and natural resource development activity.

The potential for continued habitat fragmentation is a major concern. Recent announcements by the Saskatchewan Environment and Resource Management (February 1998) of large-scale habitat protection through the Representative Areas Network program, are encouraging. Nearly 1.8 million acres, part of the network of community pastures administered by the Prairie Farm Rehabilitation Administration (PFRA), is to be secured as an area for prairie ecosystem protection.

Fur harvests

The fur of swift foxes is not a much sought after commodity. In the United States, where harvesting has been greatly reduced since 1982, pelt prices varied from $3-10 during the last 10 years (Kahn *et al.*, 1996). In Colorado, the state with the greatest harvest, the species remained abundant despite 55 years of harvest. Harvest of swift foxes in Kansas was prohibited until 1982. Since opening of the season in 1982, no

detectable reduction in range or numbers has been recorded. On the other hand, in South Dakota, Nebraska and Oklahoma, no increase in distribution nor abundance has occurred since protection was provided in these states.

The conclusion from the above is that it is unlikely that light harvest of foxes in areas of abundance will have a significant impact on numbers. Biological factors are likely more important in declines. Nevertheless, trapping can reduce numbers if it is widespread and intensive, as swift foxes are readily caught in traps.

Within the Canadian context, a total of 4 foxes (possibly more, but details are unrecorded) have been known to have been trapped as incidental take to trapping for other species. The loss of at least 2 foxes have been recorded due to hunting and at least 2 foxes are known to have been poisoned incidental to coyote poisoning. Details of a trapper having killed or released 9 swift foxes in Montana remains unsubstantiated. Swift foxes are becoming vulnerable when entering traps legally set for other fur bearing species. Modern trends in farming practices have resulted in increased numbers of large farms. This meant that there was an exodus of people leaving the rural settings and relocating to urban areas, resulting in the reduction of weekend and part-time trappers.

Chances of swift foxes being killed by trappers is less today than in the past. Use of roads by vehicles, and the increase of new road systems may impact foxes. To date, indications are that swift fox family units and dispersers can exist close to roads, occupied farms and towns. Field data from North Dakota, suggests that red foxes thrive in areas close to towns and occupied farmsteads, if these areas are avoided by coyotes. Red foxes from such sites could expand into open prairie areas if coyote abundance is reduced. Such appears to be the case in the border area. Red foxes were rarely seen until 1995/96 when severe winter conditions in that year and in 1996/97 allowed ranchers to kill more coyotes. Red fox numbers, based on sightings along the Alberta/Saskatchewan border area, increased in 1997 and the situation should be monitored in the future.

Impact of droughts

Swift fox ecology is linked to environmental conditions that influence food availability. It is not inconceivable that the disappearance of the species from northern ranges was linked to drastic and widespread climatic factors. Severe winters, droughts and icing of ranges are elements that impact vertebrate populations that survive in northern limits of the species ranges. In isolation, such factors may not have been of great consequence if occurrences were patchy and distinct, but the synergistic effects of competition for food, increased predation and/or diseases may account for local and widespread extirpation of the carnivore.

Droughts have become a fact of life on the Canadian prairies. The last significant drought within the Canadian swift fox study area occurred in 1988; at a time 17 foxes were being monitored. Eight of which were radio-collared. The Recovery Team, at the time, had decided to provide emergency supplemental feeding. The results were

positive. By August 1989, only one of the eight radio-collared foxes was lost, and all others had survived the critical winter conditions. Supplemental feeding has not been part of the program since 1988.

Predator control programs

Intensive predator control programs directed at coyotes, skunks and other species may affect non-target species such as swift foxes. On the other hand, if applied selectively for coyote control, swift fox/kit fox survival is enhanced due to reduction in interspecific competition (exploitive competition - competition for food or interference competition - larger predators killing smaller predators). For example, Linhard and Robinson 1972; Robinson 1953, 1961 documented the changes in composition of predator guilds as a result of coyote controls. Cypher and Scrivner (1992) reported on the population responses of kit foxes to coyote controls in the San Joaquin Valley in California. Dorrance (1992), has reviewed the status of coyotes in Alberta from 1920 to 1991.

Skunks (*Mephitis mephitis*) are primary vectors of the rabies virus in Alberta (Gunson *et al.*, 1978). The use of strychnine has been important for Alberta's rabies control program (Dorrance 1987; Hutchings 1991). Because of the impact of the disease on humans and livestock, any outbreaks are immediately dealt with vigorous anti-rabies programs. These outbreaks historically have been in southern Alberta and in potential swift fox ranges. Swift fox are vulnerable to strychnine poisoning. For skunk control the strychnine is injected into chicken eggs or tallow baits. Baits are placed in culverts, under abandoned buildings, ground dens and brush piles, hence accessible to swift foxes. Alberta Department of Agriculture is aware of the potential impact of their programs on swift fox survival, and have co-operated with the Swift Fox Recovery Team regarding areas of mutual concern. There have been no recorded incidents in Alberta of rabies in skunks for the last 3 years (J. Meeks pers. comm. - Alberta Agriculture). All recent concerns are of skunk rabies within 20 km south of the Alberta border (in Montana). The possibility of rabies in raccoons (*Procyon lotor*) is also an area of recent concern.

In southern Saskatchewan, swift fox survival may be impacted by 1080 bait programs set out for coyote control (SFRT Minutes 12-13/08/98). In 1984 Saskatchewan had implemented a "no poison" zone south of the Trans-Canada highway, and west of Highway #2 (south of Moose Jaw and to the Alberta/ Saskatchewan border). In 1994, the "no poison" zone was expanded to include areas further north. By 1997, the "no poison" zone was extended to include the entire grassland areas of the province, however, due to specific pressures from sheep ranchers, the previous "no poisoning" policy was revoked in 1998 and replaced with a much reduced "no poison" zone. The matter is under review and will likely result in some poisoning of coyotes.

SPECIAL SIGNIFICANCE OF THE SPECIES

Public interest in this species has always been very high. The foxes, and reintroduction program has received widespread media attention. A special

organization, *The Swift Fox Conservation Society* was founded in 1986 and promotes the reintroduction and conservation of swift foxes in Canada. In the 12 years of its existence, the society has focussed its activities in areas of education and fund raising to support research and educational projects. Educational work has included classroom lectures, mall show displays and developing special slide programs. The Canadian reintroduction is of special significance. The work conducted to date, and success, has continent-wide implications.

EVALUATION AND PROPOSED STATUS

COSEWIC

Quantitative analyses of reintroductions are important (Griffith *et al.*, 1989; Beck *et al.*, 1994 and Wolf *et al.*, 1996; Hein 1997, Kleiman *et al.*, 1994 and Ralls *et al.*, 1996). Designation of the species as EXTIRPATED in 1978 was based on the fact that no substantiated reports, observations or specimens were available for a 50-year period from 1928 to 1978. The carnivore is small and can easily retreat into dens, so "inconspicuousness" might have accounted for the lack of reports. However, the period from 1928 to 1978 is also one in which trappers, settlers and ranchers have been setting traps throughout the prairie areas. It is inconceivable that the species could have been present and gone unrecorded for all that time.

Following the reintroduction (1983 to 1997), swift foxes have re-occupied the Canadian prairies as part of the ecosystem in which, about 100 years before, it was a common species. Trappers in Alberta and northern Montana began catching the species and road kill reports were obtained for Saskatchewan, Alberta and northern Montana. This, in itself, is sufficient reason for downlisting the species from extirpated to another category. However, it was important to carry out surveys and conduct detailed research, to find out how secure the numbers are before a decision is made to downlist the species.

In every year of investigation since 1986, unmarked foxes were captured, which is an indication of reproduction in the field. In every year of investigation dens with pups were located. The longest time recorded for the survival of a fox in the wild was 7 years.

In the summer of 1991, survey efforts were greater than in previous years and 18 swift fox natal dens were discovered. Pairs at these dens produced 56 pups. Previous summer field work resulted in 28 litters as follows: 2 in 1986, 1 in 1987, 7 in 1988, 5 in 1989 and 13 in 1990.

Detailed ecological studies on swift foxes began in 1995 (Moehrenschlager, in prep. and Klausz 1997). Prior to 1994, numerous studies and surveys to evaluate survival had been carried out (see listings in Section L - Project Notes and Reports). Pruss (1994) began the first detailed behavioral field studies in 1991.

From 1984 to 1993, 55 pairs of foxes were studied using radio collars. Those animals produced 183 young for an average of 3.3 pups per litter (Brechtel *et al.*, 1993). Intensive trapping to survey numbers (research program) were carried out in 1990 (3 November to 7 December) and in 1996/97 (25 November, 1996 to 20 January 1997) (Cotterill 1997a). Clearly, under COSEWIC rules, the species should be upgraded from Extirpated (no longer living in Canada) to another category. The Threatened category is the most logical (a species likely to become endangered if limiting factors are not reversed), however, due to the uncertainties that contributed to the species' demise in the first place, the recommendation for now is to classify the species as Endangered (a species facing imminent extirpation).

IUCN and other conservation implications

Stanley Price (1991) recommended that reintroduction programs should be incorporated into both national and international conservation programs. Reading *et al.*, (1997) made a quantitative study on organizational aspects influencing the outcomes of a reintroduction project. Ginsberg (1994) reviewed the relevance of captive-raised canids in conservation. In retrospect, it can be seen how important these considerations are, when applied to the Canadian swift fox recovery project.

In addition to COSEWIC criteria, I have also subjected the current status review to the criteria set up through IUCN (International Union for the Conservation of Nature). In the IUCN Species Survival Commission 1996 Red List Data Book on Threatened Animals, the swift fox appears on List 2 - Lower Risk: conservation dependent (IUCN 1996).

In that regard the species falls into a category of threat - the degrees of which are critically endangered, endangered and vulnerable. The lower risk category being conservation dependent.

The Canadian/Montana swift fox population almost certainly is a "stand alone" population. IUCN has defined five criteria (A to E) for the above three categories. The sub-criteria being:

A. Declining population (past or projected)
B. Small distribution and decline or fluctuation
C. Small population size and decline
D. Very small population or very restricted distribution
E. Quantitative analysis (e.g.) population viability analysis.

For reasons outlined below, the conclusion based on the review of this report, places the Canadian/Montana swift fox population in the IUCN category of Vulnerable and Very small or Restricted. If however, the Canadian population is less than 250 foxes, then the IUCN criteria of Endangered would apply.

The Swift fox Recovery Plan (Brechtel *et al.*, 1996) identified the goal of achieving a viable, self-sustaining population of swift foxes in two geographically-distinct, but genetically-connected core populations with a spring population density averaging 5 foxes per township on 80% of suitable habitat by the year 2000. An estimate of 420 foxes was considered a suitable target. This figure was an "administrative objective", without reference to parameters relating to a minimum viable population estimate over the short, medium or long term. Now that foxes have become established, an assessment of long-term survival is required.

Currently, the swift fox population is around 300 animals and is vulnerable to:

- genetic problems due to loss of genetic variability, inbreeding, loss of heterozygosity and genetic drift.
- demographic fluctuations due to random variations in death and birth rates.
- environmental fluctuations - drought, winter severity, and possibly spring floods (at dens).
- human activities, trapping, poisoning of predators, habitat destruction.

Despite severe droughts (1988) and severe winter conditions (1995/96 and 1996/97) the population continued to thrive. The prognosis, therefore, is optimistic for the short term, but uncertain for the long term.

This raises the question - how many swift foxes are required to attain a viable minimum population? The 1996/97 survey, resulted in an estimate of 289 foxes at the 95% confidence interval (range 179-412). The 58 townships sampled constitute about 54% of the suspected range available (108 townships) in Canada. The figure of 108 townships may be an underestimate. Large areas that may be suitable are located west of the Suffield Military Base and north of the Red Deer River (see Figure 4). There are additional areas in Montana that may contain suitable habitat (Zimmerman 1998). In 1998, one such area was the site for reintroduction of 30 foxes (C. Smeeton pers. comm.)

It is important to evaluate the current (1997) population levels in relation to theoretical levels established as guidelines in general ecological theory. One estimate is the 50/500 rule (Franklin 1980; Franklin and Frankham 1998; Ralls *et al.*, 1996). Fifty individuals, considered to be necessary to maintain genetic variability in a short time frame, but 500 are required to offset genetic variability arising through mutation. A buffer is required to balance allele frequency losses due to genetic drift. The current estimate of 289 (179-412), (plus the Montana population), likely brings us close to the 420 population target originally envisioned. However, some of these foxes may not be producing young due to age, possible poor health, social status, lack of suitable mates and other factors. Therefore, the effective number of breeding individuals is less than 289, determined from surveys or the 420 target level. Rate of loss of genetic variability is based on the number of effective breeders, not the census population. A more detailed population viability analysis will have to wait for another census, incorporating the modified techniques as described by Cotterill (1997a). Such a census should include all areas with potential swift foxes in Canada and may not be necessary for

some time. The importance for releases to sites not yet occupied by swift foxes in Canada, may need to be considered as well.

Conclusion

For the time being a swift fox population level has been attained in Canada that may sustain viability in a short to medium time frame. The Canadian effort to date has been a success and it is recommended that, under COSEWIC rules, the species be downlisted from extirpated to endangered.

ACKNOWLEDGEMENTS

Far too many individuals have been involved in this program for me to acknowledge them all. For completion of this particular report I want to express my sincere thanks to Jeff Johnson, student and volunteer who was always cheerful and supportive, to Gary Weiss for his competent and effective input on the GIS maps, to Susan MacEachran for drafting the figures, to Jim Burns, Alberta Provincial Museum for review of museum records of fossil foxes, for Loney Dickson - whose administrative support was always there, despite the change of my status within CWS, to Steve Brechtel, Wayne Harris, Shelley Pruss, Ann Kitchen, Axel Moehrenschlager, Dick Russell, Karyn Scalise, Clio Smeeton, Ed Telfer, Ken Weagle, and David Nagorsen for critical review of the document. I thank Vi Jespersen and Christine Scott for their patient attention to detail in typing the manuscript. Pat Fargey, Parks Canada, provided information on the Wood Mountain releases, and Al Oeming provided insights on historical records. Jamie Meeks, Problem Wildlife Specialist, Alberta Agriculture, provided up to date information on the rabies control program. Minette Johnson, Defenders of Wildlife, kept me current on details regarding the Montana re-introduction program. The project depended on the good will and support of the ranching community. Numerous individuals along the Alberta/ Saskatchewan border have tolerated generations of students, technicians and biologists on their lands. Although there were many more, the key ranchers were the Buchanan's, the Heydlouft's, the Kuezler's, the Piotrowski's, the Saville's and the Wallburger's. Ranchers, landowners and biologists from the states of Wyoming and Colorado were most helpful in the acquisition of foxes from the wild in the United States. Without their support the Canadian program could not have been completed. The Turner Endangered Species Fund, in particular Michael Phillips, allowed me to use maps for this report that were originally drafted for another report that I had written for the agency. Partial funding provided by the Canadian Wildlife Service, Environment Canada.

LITERATURE CITED

Allen, J.A. 1870. Notes on the mammals of Iowa. Proc. Boston Soc. Nat. Hist., 13:178-194.

Allen, S.H. 1996. Investigation of furbearer occurrence with special reference to swift fox and preliminary modelling of possible swift fox population dynamics in North

Dakota 1994-1995. P.121-131 *in* S.H. Allen, J. Whitaker Hoagland, and E. Dowd Stukel, eds. Report of the swift fox conservation team 1995. Bismarck, ND.

Baird, A.B. 1858. Mammals (Part 1), *in* reports of explorations and surveys for a railroad from the Mississippi River to the Pacific Ocean. Vol. 8. 757 pp.

Beck, B.B., L.G. Rapaport, M.R. Stanley Price, and A.C. Wilson (1994). Reintroduction of captive-born animals, in *Creative conservation. Interactive management of wild and captive animals*, ed. P.J.S. Oleney.

Blus, L., G.R. Sherman and J.D. Henderson 1967. A Noteworthy record of the swift fox in McPherson County, Nebraska. J. Mamm. 48:471-472.

Bowles, J.B. 1975. Distribution and biogeography of mammals of Iowa. Spec. Publ. Mus., Texas Tech. Univ., 9:1-184. (Cited from Kahn *et al.* 1997).

Brechtel, S., L. Carbyn, G. Erickson, D. Hjertaas, C. Mamo, and P. McDougall. 1996. National recovery plan for the swift fox. Report No. 15. Ottawa: Recovery of Nationally Endangered Wildlife Committee. 29 pp.

Burns, J. A. 1991. Mid-Wisconsinan vertebrates and their environments from January Cave, Alberta, Canada. Quaternary Research. 35(2):130-143.

Carbyn, L.N. 1996. The return of the swift fox to the Canadian Prairies. Proceedings of the 4th Prairie Conservation and endangered species workshop. W. Willms and J. Dormaar, eds. Provincial Mus. of Alberta Nat. History Occas. Paper No. 23. p. 273-280.

Carbyn, L.N. 1986. Some observations on the behaviour of swift foxes in reintroduction programs within the Canadian prairies. Alberta Naturalist Vol. 16(2):37-41.

Carbyn, L.N., H.J. Armbruster, and C. Mamo. 1994. The swift fox reintroduction program in Canada from 1983 to 1992. p. 247-270 *in* M.L. Bowles and C.J. Whelan. Restoration of endangered species: conceptual issues, planning and implementation. Cambridge University Press.

Carbyn, L., S. Brechtel, D. Hjertaas, and C. Mamo. 1993. An update on the swift fox reintroduction program in Canada. Proceedings of the 3rd Prairie Conservation and Endangered Species Workshop. G. Holroyd, H. Dickson, M. Regnier, H. Smith, Eds. Provincial Mus. of Alberta. Nat. History. Occas. Paper No. 19 p. 366-372.

Carbyn, L.N. and M. Killaby. 1989. Status of the swift fox in Saskatchewan. Blue Jay, 47:41-52.

Carlington, B.G. 1980. Reintroduction of the swift fox to the Canadian prairie. Master's Degree Project, Faculty of Environmental Design, University of Calgary, Calgary, Alberta. 180 pp.

Chambers, G.D. 1978. Little fox on the prairie. Audubon 80(4):62-71.

Cochrane Ecological Institute. 1996. Scent post survey for swift fox (*Vulpes velox*) in the West Block, Grasslands National Park, 1995. Heritage Resource Management Grasslands National Park - 1995 Annual report Vol. 1. p. 55-60.

Covell, D.F. 1992. Ecology of the swift fox (*Vulpes velox*) in southeastern Colorado. Unpubl. M.S. Thesis, Univ. of Wisconsin, Madison. 111 pp.

Cotterill, S.E. 1997a. Population Census of swift fox (*Vulpes velox*) in Canada: Winter 1996-1997. Alberta Environmental Protection, Natural Resources Service. 50 pp.

Cotterill, S.E. 1997b. Status of the swift fox (*Vulpes velox*) in Alberta. Alberta Environmental Protection, Wildlife Management Division, Wildlife Status Report No. 7. Edmonton, AB. 17 pp.

Coupland, R. T. 1950. Ecology of mixed prairie in Canada. Ecol. Monogr. 20:270-315.

Coupland, R.T. 1987. Proceedings of the Workshop on Endangered Species in the prairie provinces. Endangered Prairie Habitats. The Mixed Prairie. p. 35-41.

Cutter, W.L. 1958. Denning of the swift fox in northern Texas. J. Mamm. 39: 70-74

Cypher, B.L., and J.H. Scrivner. 1992. Coyote control to protect endangered San Joaquin kit foxes at the Naval Petroleum Reserves, California. Proc. 15th Vertebrate Pest Conf. p. 42-47.

Dalquest, W.W. 1978. Early Blancan mammals of the Beck Ranch local fauna of Texas. Jour. Mammal. 59:269-298.

Dorrance, M. J. 1992. Coyote control in Alberta. p. 171-182 *in*Ecology and Management of the Eastern Coyote Symposium. A.H. Boer, ed. Wildlife Research Unit, University of New Brunswick. Fredericton, New Brunswick. 194 pp.

Dragoo, G., G.R. Choate, T.L. Yates, and T.P. O'Farrell. 1990. Evolutionary and taxonomic relationships among North American arid-land foxes. J. Mammal. (7):318-332.

Egoscue, H.J. 1956. Preliminary studies of the kit fox in Utah. J. Mamm. 37:351-357.

Egosue, H.G. 1962. Ecology and life history of the kit fox in Tooele County, Utah. Ecology, 43:481-497.

Egoscue, H.J. 1975. Population dynamics of the kit fox in western Utah. Bull. Southern California Acad. Sci. 74:122-127.

Egoscue, H.J. 1979. *Vulpes velox*. Mammalian species. Lawrence, Kansas, Am. Soc. Mamm., 122:1-5.

Erickson, A.B. 1944. Helminths of Minnesota Canidae in relation to food habits and a host list and key to species reported from North America. Amer. Midl. Nat., 32:358-372.

FaunaWest Wildlife Consultants. 1991. An ecological and taxonomic review of the swift fox (*Vulpes velox*) with special reference to Montana. Boulder, M.T. 49 pp.

FaunaWest Wildlife Consultants. 1986. A proposal to reintroduce the swift fox to the Charles M. Russell National Wildlife Refuge. Mimeo. Boulder, Montana. 14 pp.

Floyd, B.L. and M.R. Stromberg. 1981. New records of the swift fox *(Vulpes velox)* in Wyoming. J. Mamm. 62:650-651.

Fitzgerald, J.P., R.R. Loy, and M. Cameron. 1983. Status of the swift fox on the Pawnee National Grassland, Colorado. Unpubl. manuscript. Univ. of N. Colo., Greeley. 21 pp.

Franklin, I.R. 1980. Evolutionary change in small populations. *In* M.E. Soule and B.A. Wilcox (eds.) Conservation Biology: An Evolutionary-Ecological Perspective. p. 135-149. Sinauer Associates, Sunderland M.A.

Franklin, I. R. and R. Frankham (1998). How large must populations be to retain evolutionary potential? *Animal Conservation* 1:69-70.

Gauthier, D.A. and L. Patino, 1993. Saskatchewan Grassland Ecological Region. Prepared for the Canadian Council of Ecological Areas and the World Wildlife Fund Canada. Canadian Plains Research Centre. 47 pp.

Giddings, B. and C.J. Knowles. 1995. The current status of swift fox in Montana. p. 101-120 *in* S.H. Allen, J. Whitaker Hoagland, and E. Dowd Stukel, eds. Report of the swift fox conservation team. Bismarck, ND.

Ginsberg, J. R. (1994). Captive breeding, reintroduction and the conservation of canids, in *Creative conservation. Interactive management of wild and captive animals*, eds. P.J.S. Oleney, G.M. Mace, and A.T.C. Freistner.

Griffith, B., Scott, J.M., J.W. Carpenter, and C. Reed 1989. Translocation as a species conservation tool: status and strategy. *Science* 245:477-480.

Gunson, J. R., W.J. Dorward, and D. B. Schowalter. 1978. An evaluation of rabies control in skunks in Alberta. Can. Vet. J. 19:214-220.

Hall, E.R. 1981 The mammals of North America. Vol. II. 2nd ed. John Wiley and Sons, N.Y. p. 939-941.

Hein, E.W. 1997. Improving translocation programs. Conservation Biology 11:1270-1271.

Herrero, S. C. Schroeder and M. Scott-Brown. 1986. Are Canadian foxes swift enough? Biol. Conserv. 36:1-9.

Hillman, C.N. and J.C. Sharps. 1978. Return of the swift fox to the Northern Great Plains. Proc. South Dakota. Acad. Sci. 57:154-162.

Hines, T.D. 1980a. Home range and movements of swift fox as determined by radio telemetry. Proc. Nebr. Acad. Sci. Affil. 90:7.

Hines, T.D. 1980b. An ecological study of *Vulpes velox* in Nebraska. Master's thesis, University of Nebraska, Lincoln, Nebraska. 103 pp.

Hines, T.D., and R.M. Case 1991. Diet home range, movements, and activity period of swift fox in Nebraska. Prairie Naturalist 23:131-138.

Hoffman, R.S., P.L.Wright, and F.E. Newby. 1969. The distribution of some mammals in Montana. J. Mammal. 50:579-604.

Hutchings, E. 1991. Rabies control in Alberta, January 1 to Dec. 31, 1990. Alberta Agriculture Report. 8 pp.

IUCN 1996. 1996 IUCN Red List of Threatened Animals. IUCN, Gland, Switzerland. 368 pp.

Jackson, V. 1997. Denning Ecology of swift foxes (*Vulpes velox*) in Western Kansas. Final report. Kansas Department of Wildlife and Parks. 23 pp.

Kahn, R., and J. Fitzgerald, 1995. Swift fox investigations in Colorado (1995). Pages 53-60 *in* S.H. Allen, J. Whitaker Hoagland, and E. Dowd Stukel, eds. Report to the Swift fox Conservation Team 1995. Bismarck, ND.

Kahn, R., L. Fox, P. Horner, and B. Giddings. 1996. Conservation Assessment and Conservation Strategy for swift foxes in the United States. Report by the swift fox Conservation Team. 54 pp.

Kahn, R., L. Fox, H. Horner, B. Giddings, and C. Roy 1997. Conservation Assessment and Conservation Strategy for swift fox in the United States. Swift fox Conservation Team. 54 pp.

Kilgore, D.L. 1969. An ecological study of the swift fox (*Vulpes velox*) in the Oklahoma panhandle. Am. Midl. Nat. 81:512-534.

Kitchen, A., E. Gese, and E. Schauster. Resource partitioning between swift foxes and coyotes: space, time and diet. Abstract. First North American. Swift Fox Symposium.

Klausz, E. 1997. Small mammal winter abundance and distribution in the Canadian mixed Grass Prairies and implications for the Swift fox. M.Sc. Thesis. University of Alberta. 108 pp.

Kleiman, D.G., M.R. Stanley Price, and B.B. Beck. (1994). Criteria for reintroductions. In *Creative conservation. Interactive management of wild and captive animals*, eds. P.J.S. Olney, G.M. Mace, and A.T.C. Feistner, p. 287-303. London: Chapman and Hall.

Kruse, K.W., J.A. Jenks, and E. Dowd Stukel. 1996. Presence of swift fox (*Vulpes velox*) in southwestern South Dakota. p. 91-99 *in* .H. Allen, J. Whitaker Hoagland, and E. Dowd Stukel, eds. Report of the swift fox Conservation Team. 1995. Bismarck, ND.

Kurten, B. and E. Anderson. 1980. Pleistocene Mammals of North America. Columbia University Press, New York. 553 pp.

Lauenroth, B. 1996. Results of vegetation studies on Pawnee grassland. p. 20-26 *in* D.P. Coffin, ed. Summary report: shortgrass prairie/mountain plover workshop. Fort Collins, CO. (cited from Kahn *et al.* 1997).

Licht, D. 1997. Ecology and Economics of the Great Plains. University of Nebraska. Vol. 10. Our Sustainable Future 225 pp.

Lindberg, 1986. Swift fox distribution in Wyoming: a biogeographical study. M.Sc. Thesis. Univ. of Wyoming. Laramie. 64 pp.

Linhart, S.B., and W.B. Robinson. 1972. Some relative carnivore densities in areas under sustained coyote control. J. Mamm. 53:880-884.

Looman, J. 1972. Possible recent kit fox record in Saskatchewan. Blue Jay 30:136.

Major, J.T., and J.A. Sherburne. 1987. Inter-specific relationships of coyotes, bobcats and red foxes in western Maine. J. Wildl. Manage. 51:606-616.

Mercure, A., K. Ralls, K.P. Koepli, and R.K. Wayne. 1983. Genetic subdivisions among small canids: mitochondrial differentiation of swift, kit and arctic foxes. Evolution 47(5):1313-1328.

Meriam, C.H. 1902. Three new foxes of the kit and desert fox.

Moehrenschlager, A., and R. List. 1996. Comparative ecology of North American prairie foxes - conservation through collaboration. The Wildcru Review. Oxford University. p. 22-28.

Moore, R.E., and N.S. Martin. 1980. A recent record of the swift fox (*Vulpes velox*) in Montana. J. Mammal. 61:161.

Novakowski, N. 1970. Endangered Canadian mammals. Canadian Field Naturalist. 84:17023.

Nowak, R.M. and J.L. Paradiso. 1983 Mammals of the world 4th ed. 2 vols. John Hopkins Univ. Press, Baltimore, Md. 1362 p.

Parmalee, P.W. R.D. Oesch, and J. E. Guilday. 1969. Pleistocene and Recent vertebrate faunas from Crankshaft Cave, Missouri. Illinois State Museum Reports of Investigations. 14:1-37.

Pattimore, J. 1985. The feasibility of reintroducing the swift fox in Manitoba. M.Sc. Thesis. University of Manitoba.

Pfeifer, W.K. and E.A. Hibbard. 1970. A recent record of the swift fox (*Vulpes velox*) in North Dakota. J. Mammal. 51:835.

Prairie Conservation Action Plan 1994. World Wildlife Fund Canada. 38 pp.

Pruss, S. 1994. An observational natal den study of wild swift fox (*Vulpes velox*) on the Canadian Prairie. M.Sc. Thesis, University of Calgary.

Ralls, K. and P.J. White. 1995. Predation on San Joaquin kit foxes by larger canids. J. Mammal. 76:723-729.

Ralls, K. D.P. Demaster, and J.A. Estes 1996. Developing a criterion for delisting the southern sea otter under the U.S. endangered species act. Conservation Biology 10:1528-1537.

Rand, A.L. 1948. Mammals of the eastern Rockies and western plains of Canada. Bull. Nat. Mus. Can., 108. 237 pp.

Reading, R.P. T.W. Clark, and B. Griffith 1997. The influence of valuational and organizational considerations on the success of rare species translocations. Biological Conservation 79:217-225.

Reynolds, J. 1983 (a). A plan for reintroduction of the swift fox to the Canadian Prairie. Master's Degree Project, Faculty of Environmental Design, University of Calgary, Calgary, Alberta. 112 pp.

Robinson, W.B. 1953. Population trends of predators and fur animals in 1080 station areas. J. Mammal. 34:220-227.

Robinson, W.B. 1961. Population changes of carnivores in some coyote-control areas. J. Mamm. 42:510-515.

Rohwer, S.A. and D.L. Kilgore. 1973. Interbreeding in the arid-land foxes, *Vulpes velox* and *V. macrotis*. Systematic Zoology, 22:157-166.

Rosatte, R.C. 1987. Striped, spotted, hooded, and hog-nosed skunk. p. 598-613 *in* Wild furbearer management and conservation in North America. (M. Novak, J.A. Baker, M.E. Obbard, and B. Malloch, eds.) Ontario Trappers Association, North Bay, ON.

Rowe, J.S. and R.T. Coupland. 1984. Vegetation of the Canadian Plains. Prairie Forum. 9:231-248.

Russell, R.H. and G.W. Scotter. 1984. Return of the native. Nature Canada. 13(1):7-13.

Samuel, D.E.,= and B.B. Nelson. 1982. Foxes, *Vulpes vulpes*, and allies. *In* J.A. Chapman, and G.A. Feldhamer, ed. Wild Mammals of North America. 1147 pp.

Saskatchewan Dept. of Tourism and Renewable Resources. 1978. The status of the swift fox in Canada. Saskatchewan Department of Tourism and Renewable Resources. Ottawa. 5 pp.

Sargeant, A.B., R.J. Greenwood, M.A. Sovada, and T.L. Shaffer, 1993. Distribution and abundance of predators that affect duck production - Prairie Pothole Region. Res. Pub. 194. Washington, D.C. U.S. Fish and Wildlife Service.

Schitoskey, F. Jr. 1975. Primary and secondary hazards of three rodenticides to kit foxes. J. Wildl. Manage. 39(2): 416-418.

Schmutz, J.K., S.M. Schmutz, and D.A. Boag. 1980. Coexistence of three species of hawks (*Buteo* spp.) in the prairie-parkland ecotone. Can. J. Zool. 58:1075-1089.

Schroeder, C.A. 1985. A preliminary management plan for securing swift fox for reintroduction into Canada. Master's Degree Project, Faculty of Environmental Design, University of Calgary, Calgary, Alberta.

Schroeder, C.A. 1982. A cooperative propagation and release program for the endangered swift fox. Am. Assoc. Zool. p. 287-295.

Sharps, J.C. and M.F. Witcher. 1981. Swift fox reintroduction techniques. Unpubl. report, South Dakota Dept. of Game, Fish and Parks, Rapid City, S.D.
Smeeton, M. 1984. Completely Foxed. Key Porter Books. 148 pp.
Smeeton, C. 1994. Re-introducing the swift fox. Canid Action News. Newsletter of the Canid Specialist Group. IUCN 2:13-16.
Smeeton, C. 1996. The Swift Fox Recovery Program. Environment Network News. No. 46:11-13.
Soper, J.D. 1964. The mammals of Alberta. Hanly Press Ltd., Edmonton. 402 pp.
Stanley Price, M.R. (1991). A review on mammal re-introductions, and the role of the Re-introduction Specialist Group of IUCN/SCC. Symp. Soc. Zool. Lond. 62:9-25.
Stromberg, M.R. and M.S. Boyce. 1986. Systematics and Conservation of the Swift fox (*Vulpes velox*) in North America. Biol. Conserv. 35:97-110.
Swanson, G.A., T. Surbar, and T.S. Roberts. 1945. The Mammals of Minnesota. Minnesota Dept. Conserv. Div. Game & Fish Tech. Bull. 2:1-108.
Telfer, E., L.N. Carbyn, R. Clark, B. Dale, E. Driver, G. Holroyd, and G. Trottier. 1993. Canadian Wildlife Research and Management in the Grasslands and Parklands of Prairie Canada. Canadian Wildlife Service Report. 58 pp.
U.S. Fish and Wildlife Service. 1979. Federal Register, 17 June 1979, p. 3638.
U.S. Fish and Wildlife Service. 1982. Federal Register, 30 December 1982, p. 58454-58460.
U.S. Fish and Wildlife Service. 1994. Fed. Reg., Vol. 59, No. 104, June 1, 1994. Endangered and threatened wildlife and plants; 90-day finding on a petition to list the swift fox as endangered. p. 28328-28329. Dept. of the Interior, Washington, DC.
U.S. Fish and Wildlife Service 1995. Fed. Reg. Vol. 60, No. 116, June 16, 1995. Endangered and threatened wildlife and plants; 12-month finding for a petition to list the swift fox as endangered. p. 31663-31666, Dept. of the Interior, Washington, DC.
Voigt, D.R. 1987. Red fox. p. 378-392 *in* Wild Furbearer management and on conservation in North America. (M. Novak, J.A. Baker, M.E. Obbard, and B. Malloch, eds.). Ontario Trappers Assoc., North Bay, ON.
Voigt, D.R. and W.E. Berg, 1987. Coyote. p. 345-357 *in* Wild Furbearer management and conservation in North America. (M. Novak, J.A. Baker, M.E. Obbard, and B. Malloch, eds.). Ontario Trappers Association, North Bay, ON.
Wedgwood, J.A. 1978. The status of the Burrowing Owl in Canada. A report prepared for the Committee on the Status of Endangered Wildlife in Canada. Can. Wildl. Serv., Ottawa, ON.
Wellicome, J.I. and E.A. Haug. 1995. Second update of status report on the Burrowing Owl (*Speotyto cunicularia*) in Canada. COSEWIC report. 23 pp.
Whitaker-Hoagland, J. 1997. A review of literature related to swift fox habitat use. Swift fox conservation team annual report B. Gidding editor. p. 113-125.
Wolf, C.M., B. Griffith, C. Reed, and S.A. Temple 1996. Avian and mammalian translocations: update and reanalysis of 1987 survey data. Conservation Biology 10:1142-1154.
Wooley, T.P., F.G. Lindzey, and R. Rothwell. 1995 Swift fox surveys in Wyoming. Annual Report. Wyoming Game and Fish Department, Lander, WY. 20 pp.

Zimmerman, A.L. 1998. Re-establishment of swift fox in north-central Montana. M. Sc. thesis. Montana State University, Bozeman, Montana. 44 pp.
Zumbaugh, D.M., J.R. Choate, and L.B. Fox. 1985. Winter food habits of the swift fox on the central high plains. Prairie Nat. 17:41-47.

PROJECT NOTES AND REPORTS

Brechtel, S.H., L.N. Carbyn, D. Hjertaas, and C. Mamo. 1993. Canadian swift fox reintroduction feasibility study: 1989-1992. Report and recommendations of the National Recovery Team. 116 pp.
Brechtel, S.H., L.N. Carbyn. D. Hjertaas and C. Mamo. 1994. Status report on the Swift fox in Canada. Recovery Team Report. 40 pp.
Carbyn, L.N. and C. Schroeder. 1987. Preliminary Recovery Plan Proposal for the swift fox Program in Canada. Unpublished report for the Canadian Wildlife Service. Edmonton, AB. 100 pp.
Carbyn, L.N. 1990. Swift Fox Annual Project Report. 55 pp.
Carlington, B.G. 1978 Feasibility Study; re-introduction of the swift fox to southern Alberta. Interim report. Univ. of Calgary; Faculty of Environmental Design. 69 pp.
Cochrane Ecological Institute 1993. Site selection and the use of "A" Frames for the 1993 swift fox releases within Grasslands National Park. 37 pp. Unpublished Report.
Dorrance, M. 1987. Strychnine for Skunk control: Baits, Baiting Procedures and Non-Target Hazards. Alberta Agriculture Crop Protection Branch. 10 pp.
Fisher, Susan. 1993. Public Awareness Campaign, swift fox Program Report. 14 pp.
Harris, Wayne, C. and S. M. McAdam. 1994. Assessment of Swift fox populations in Saskatchewan-winter/spring 1994. Prepared for Swift fox Conservation Society and Saskatchewan Environment and Resource Management Wildlife Branch. 8 pp.
Herrero, S. and C. Mamo. 1987. Swift fox Reintroduction Progress Report. Faculty of Environmental Design Report for World Wildlife Fund. 7 pp.
Hjertaas, D. 1994. Reintroduction of the swift fox on the Wood Mountain Plateau. Department of Environment and Resource Management Report. Regina. 14 pp.
Herrero, S., C. Mamo, H. Armbruster and L.N. Carbyn. 1989. Swift fox reintroduction: Progress Report. 1989. Faculty of Environmental Design Report. 19 pp.
Mamo, C. 1987. (a) Swift fox habitat assessment. Unpub. Rept., Univ. of Calgary, Faculty of Envir. Design, Swift fox Res. Group, Calgary, Alberta. 10 pp.
Mamo, C. 1988. Update of swift fox monitoring in Alberta. Reporting period from 28 February 1987 to 10 March 1988. Project Progress Report. 49 pp.
Mamo, C. 1994a. (a) Swift fox Population Survey (1994). Prepared for Alberta Fish and Wildlife and The swift fox Conservation Society. 30 pp.
Mamo, C. 1994. (b) Swift fox habitat survey. Report prepared for Alberta Fish and Wildlife. 25 pp.
Mamo, C. 1994. (c) Swift Fox population survey assessment. Progress Reports prepared for Alberta Fish and Wildlife and for the Swift Fox Conservation Society. 30 pp.
Mamo, C. 1995. Swift Fox Playback trails. Report prepared for Alberta Fish and Wildlife Service. 12 pp.

Mamo, C. and S. Herrero. 1987. Update of swift fox Monitoring in Alberta. Reporting Period from 31 January 1986 to 28 February 1987. Progress Report - 1987. Prepared for Canadian Wildlife Service. 12 pp. and appendices.

Mamo, C., H. Armbruster, S. Herrero and Lu Carbyn 1990. Swift fox reintroduction techniques and results, 1989 - 1980 Program Report. 11 pp. Project Report , 17 pp.

Mamo, C. and K. Sturgess. 1991. Progress Report. Recovery Team document. 16 pp.

Moehrenschlager, A. 1994. Population monitoring of swift foxes by means of scent-posting and spot-lighting in Wood Mountain. Progress Report 17 pp.

Reynolds, J. 1983b. Evaluation of potential Swift fox release areas in southwestern Saskatchewan. Canadian Wildlife Service Report. 22 pp.

Reynolds, J. 1983c. Reintroduction of the Swift fox to the Canadian Prairie. A slide presentation on the Swift fox Reintroduction Project. Canadian Wildlife Service Report. 9 pp.

Reynolds, H.W., J. Reynolds and M.G. Killaby. 1984. Preliminary Evaluation of Potential Swift fox release areas in southern Saskatchewan. Canadian Wildlife Service and Saskatchewan Parks and Renewable Resources Report. 23 pp.

Russell, R. 1983. A proposal to reintroduce the Swift fox to Alberta. Canadian Wildlife Service Report. 19 pp.

Russell, R.H. and J. Zendran. 1983. A proposal to reintroduce the Swift fox to Alberta. Canadian Wildlife Service Report. 21 pp.

Russell, R.H., G. Erickson and J. Reynolds. 1984. A preliminary plan for management of the swift fox in Alberta. Joint Canadian Wildlife Service, Alberta Fish and Wildlife report. 14 pp.

Scott-Brown, J.M., S. Herrero and J. Reynolds. 1987. Swift fox. p. 433-441, *in* M. Novak, G.A. Baker, M.E. Obbard and B. Malloch, eds. Wild Furbearer Management and Conservation in North America Ont., Trappers Assoc., Ministry of Nat. Resources, Ont. 1168 pp.

Scott-Brown, J.M., Herrero, S. and Mamo, C. 1986. Monitoring of released swift foxes in Alberta and Saskatchewan, Final Report - 1986. Prepared for Canadian Wildlife Service. 71 pp. and appendices.

Scott-Brown, J.M. and S. Herrero 1985. Monitoring of released Swift foxes in Alberta and Saskatchewan. Progress Report. 62 pp.

Scott-Brown, J.M. and J. Reynolds. 1984. Monitoring of released Swift foxes. Canadian Wildlife Service Report. 6 pp.

Smeeton, Clio. 1992. Report on the fall 1992 re-introduction of swift fox into prairie dog towns on Dixon's Range, Mankota, Sask. Program Report 4 pp.

Swift fox Recovery Team. 1991. Swift fox interim management Plan based on experience gained from 1983 to 1990. Recovery Team document. 37 pp.

Taggart, J. 1994. Survival of Wyoming Swift foxes. Alberta Fish and Wildlife Report. 28 pp.

THE AUTHOR

Ludwig N. Carbyn was born in South-West Africa (Namibia) and did his under-graduate studies in biology at Mount Allison University in New Brunswick. He received

graduate training from the Max Planck Institute (University of Munich), the University of Alberta (M.Sc.), and the University of Toronto (Ph.D.). His research interests have included avian ecology, ecosystem biology (grasslands), and studies on mammals in several western and northern Canadian national parks. He became a biologist with the Canadian Wildlife Service in 1967 and a research scientist in 1974, and has served on assignments in Poland and Portugal. Carbyn is the Canadian member of the International Union for the Conservation of Nature and Natural Resources (IUCN) Wolf Specialist Group, Canid Group. He is currently a research scholar with the Circumpolar Institute Re-introduction Specialist Group (University of Alberta), and adjunct professor, Department of Renewable Resources and Research Scientist Emeritus, Canadian Wildlife Service. Dr. Carbyn was a member of the Swift Fox Technical Committee from 1985 to 1989, served as chairman of the Canadian Swift Fox Recovery Team (1989-1992) and currently is a member of the Canadian Swift Fox Recovery Team and a member of the American Swift Fox Conservation Committee.